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CONTENTS

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LIST OF MEETINGS AND PAST OFFICERS

First Annual Meeting, Washington, D. C., Nov. 12–14, 1889. President, C. V. Riley; First Vice-President, S. A. Forbes; Second Vice-President, A. J. Cook; Secretary, John B. Smith.

Second Annual Meeting, Champaign, Ill., Nov. 11–13, 1890. (The same officers had charge of this meeting.)

Third Annual Meeting, Washington, D. C., Aug. 17–18, 1891. President, James Fletcher; First Vice-President, F. H. Snow; Second Vice-President, Herbert Osborn; Secretary, L. O. Howard.

Fourth Annual Meeting, Rochester, N. Y., Aug. 15–16, 1892. President, J. A. Lintner; First Vice-President, S. A. Forbes; Second Vice-President, J. H. Comstock; Secretary, F. M. Webster.

Fifth Annual Meeting, Madison, Wis., Aug. 14–16, 1893. President, S. A. Forbes; First Vice-President, C. J. S. Bethune; Second Vice-President, John B. Smith; Secretary, H. Garman.

Sixth Annual Meeting, Brooklyn, N. Y., Aug. 14–15, 1894. President, L. O. Howard; First Vice-President, John B. Smith; Second Vice-President, F. L. Harvey; Secretary, C. P. Gillette.

Seventh Annual Meeting, Springfield, Mass., Aug. 27–28, 1895. President, John B. Smith; First Vice-President, C. H. Fernald; Secretary, C. L. Marlatt.

Eighth Annual Meeting, Buffalo, N. Y., Aug. 21–22, 1896. President, C. H. Fernald; First Vice-President, F. M. Webster; Second Vice-President, Herbert Osborn; Secretary, C. L. Marlatt.

Ninth Annual Meeting, Detroit, Mich., Aug. 12–13, 1897. President, F. M. Webster; First Vice-President Herbert Osborn; Second Vice-President, Lawrence Bruner; Secretary, C. L. Marlatt.

Tenth Annual Meeting, Boston, Mass., Aug. 19–20, 1898. President, Herbert Osborn; First Vice-President, Lawrence Bruner; Second Vice-President, C. P. Gillette; Secretary, C. L. Marlatt.

Eleventh Annual Meeting, Columbus, Ohio, Aug. 18–19, 1899. President, C. L. Marlatt; First Vice-President, Lawrence Bruner; Second Vice-President, C. P. Gillette; Secretary, A. H. Kirkland.

Twelfth Annual Meeting, New York, N. Y., June 22–23, 1900. President, Lawrence Bruner; First Vice-President, C. P. Gillette; Second Vice-President, E. H. Forbush; Secretary, A. H. Kirkland.

Thirteenth Annual Meeting, Denver, Colo., Aug. 23–24, 1901. President, C. P. Gillette; First Vice-President, A. D. Hopkins; Second Vice-President, E. P. Felt; Secretary, A. L. Quaintance.

Fourteenth Annual Meeting, Pittsburgh, Pa., June 27–28, 1902. President, A. D. Hopkins; First Vice-President, E. P. Felt; Second Vice-President, T. D. A. Cockerell; Secretary, A. L. Quaintance.

Fifteenth Annual Meeting, Washington, D. C., Dec. 26–27, 1902. President, E. P. Felt; First Vice-President, W. H. Ashmead; Second Vice-President, Lawrence Bruner; Secretary, A. L. Quaintance.

Sixteenth Annual Meeting, St. Louis, Mo., Dec. 29–31, 1903. President, M. V. Slingerland; First Vice-President, C. M. Weed; Second Vice-President, Henry Skinner; Secretary, A. F. Burgess.

Seventeenth Annual Meeting, Philadelphia, Pa., Dec. 29–30, 1904. President, A. L. Quaintance; First Vice-President, A. F. Burgess; Second Vice-President, Mary E. Murtfeldt; Secretary, H. E. Summers.

Eighteenth Annual Meeting, New Orleans, La., Jan. 1–4, 1906. President, H. Garman; First Vice-President, E. D. Sanderson; Second Vice-President, F. L. Washburn; Secretary, H. E. Summers.

Nineteenth Annual Meeting, New York, N. Y., Dec. 28–29, 1906. President, A. H. Kirkland; First Vice-President, W. E. Britton; Second Vice-President, H. A. Morgan; Secretary, A. F. Burgess.

Twentieth Annual Meeting, Chicago, Ill., Dec. 27–28, 1907. President, H. A. Morgan; First Vice-President, H. E. Summers; Second Vice-President, W. D. Hunter; Secretary, A. F. Burgess.

Twenty-first Annual Meeting, Baltimore, Md., Dec. 28–29, 1908. President, S. A. Forbes; First Vice-President, W. E. Britton; Second Vice-President, E. D. Ball; Secretary, A. F. Burgess.

Twenty-second Annual Meeting, Boston, Mass., Dec. 28–29, 1909. President, W. E. Britton; First Vice-President, E. D. Ball; Second Vice-President, H. E. Summers; Secretary, A. F. Burgess.

Twenty-third Annual Meeting, Minneapolis, Minn., Dec. 28–29, 1910. President, E. D. Sanderson; First Vice-President, H. T. Fernald; Second Vice-President, P. J. Parrott; Secretary, A. F. Burgess.

Twenty-fourth Annual Meeting, Washington, D. C., Dec. 27–29, 1911. President, F. L. Washburn; First Vice-President, E. D. Ball; Second Vice-President, R. H. Pettit; Secretary, A. F. Burgess.

Twenty-fifth Annual Meeting, Cleveland, Ohio, Jan. 1–3, 1913. President, W. D. Hunter; First Vice-President, T. J. Headlee; Second Vice-President, R. A. Cooley; Secretary, A. F. Burgess.

Twenty-sixth Annual Meeting, Atlanta, Ga., Dec. 31, 1913–Jan. 2, 1914. President, P. J. Parrott; First Vice-President, E. L. Worsham; Second Vice-President, Wilmon Newell; Secretary, A. F. Burgess.

Twenty-seventh Annual Meeting, Philadelphia, Pa., Dec. 28–31, 1914. President, H. T. Fernald; First Vice-President, Glenn W. Herrick; Second Vice-President, W. E. Britton; Third Vice-President, Wilmon Newell; Secretary, A. F. Burgess.

Special Meeting, Berkeley, Cal., Aug. 9–10, 1915. (Officers same as for Twenty-eighth Annual Meeting.)

Twenty-eighth Annual Meeting, Columbus, Ohio, Dec. 27–30, 1915. President, Glenn W. Herrick; First Vice-President, R. A. Cooley; Second Vice-President, W. E. Rumsey; Third Vice-President, E. F. Phillips; Secretary, A. F. Burgess.

Twenty-ninth Annual Meeting, New York, N. Y., Dec. 28–30, 1916. President, C. Gordon Hewitt; First Vice-President, G. A. Dean; Second Vice-President, E. D. Ball; Third Vice-President, W. J. Schoene; Fourth Vice-President, T. J. Headlee; Secretary, A. F. Burgess.

Thirtieth Annual Meeting, Pittsburgh, Pa., Dec. 31, 1917–Jan. 2, 1918. President, R. A. Cooley; First Vice-President, W. E. Hinds; Second Vice-President, A. W. Morrill; Third Vice-President, G. M. Bentley; Fourth Vice-President, B. N. Gates; Secretary, A. F. Burgess.

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Proceedings of the Thirty-First Annual Meeting of the American Association of Economic Entomologists

The thirty-first annual meeting of the American Association of Economic Entomologists was held in Room 9, Gilman Hall, Johns Hopkins University, Baltimore, Maryland, December 26 and 27, 1918.

The meeting convened at 10.30 a. m., December 26, when the annual reports were presented and the address of the President was given.

The session was continued in the afternoon of the same day, and in the evening the Section on Apiculture met at 8.00 p. m., when a program of papers was presented.

At the morning session, December 27, a joint meeting of the Association and the Section on Horticultural Inspection was held.

The final meeting of the Association was held in the afternoon. The business proceedings of the Association are given in Part I of this report, and the address, papers and discussions appear as Part II.

The proceedings of the Section on Apiculture will be prepared by the Sectional Secretary and published as part of this report.

PART I. BUSINESS PROCEEDINGS

The meeting was called to order by President E. D. Ball, at 10.30 a. m., Thursday, December 26, 1918. About 100 members and visitors attended the sessions. The following members were present:

J. M. Aldrich, Washington, D. C.
R. H. Allen, Boston, Mass.
E. D. Ball, Ames, Iowa.
P. T. Barnes, Harrisburg, Pa.
G. G. Becker, Fayetteville, Ark.
G. M. Bentley, Knoxville, Tenn.
S. W. Bilsing, College Station, Texas.
M. W. Blackman, Syracuse, N. Y.
W. E. Britton, New Haven, Conn.
A. F. Burgess, Melrose Highlands, Mass.
August Busck, Washington, D. C.
D. J. Caffrey, Hagerstown, Md.
W. W. Chase, Atlanta, Ga.
Mel T. Cook, New Brunswick, N. J.

E. N. Cory, College Park, Md.
E. C. Cotton, Columbus, Ohio.
C. R. Crosby, Ithaca, N. Y.
J. J. Davis, West Lafayette, Ind.
G. A. Dean, Manhattan, Kan.
J. E. Dudley, Jr., Madison, Wis.
E. P. Felt, Albany, N. Y.
S. W. Frost, Arendtville, Pa.
A. B. Gahan, Berwyn, Md.
Philip Garman, College Park, Md.
C. P. Gillette, Fort Collins, Colo.
W. H. Goodwin, Riverton, N. J.
H. A. Gossard, Wooster, Ohio.
T. L. Guyton, Harrisburg, Pa.
C. H. Hadley, Jr., Bustleton, Pa.
T. J. Headlee, New Brunswick, N. J.
P. H. Hertzog, Hightstown, N. J.
A. D. Hopkins, Washington, D. C.
J. S. Houser, Wooster, Ohio.
L. O. Howard, Washington, D. C.
J. A. Hyslop, Washington, D. C.
T. H. Jones, Baton Rouge, La.
Max Kisliuk, Wilmington, N. C.
O. A. Larson, Logan, Utah.
R. W. Leiby, Raleigh, N. C.
A. C. Lewis, Atlanta, Ga.
Z. P. Metcalf, West Raleigh, N. C.
Harold Morrison, Washington, D. C.
W. C. O'Kane, Durham, N. H.
Herbert Osborn, Columbus, Ohio.
R. C. Osburn, Columbus, Ohio.
T. H. Parks, Columbus, Ohio.
P. J. Parrott, Geneva, N. Y.
Alvah Peterson, New Brunswick, N. J.
W. D. Pierce, Washington, D. C.
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J. K. Primm, Oak Lane, Pa.
A. L. Quaintance, Washington, D. C.
W. S. Regan, Amherst, Mass.
R. R. Reppert, Blacksburg, Va.
W. A. Riley, St. Paul, Minn.
J. M. Robinson, Auburn, Ala.
V. I. Safro, Louisville, Ky.
J. G. Sanders, Harrisburg, Pa.
E. D. Sanderson, Ithaca, N. Y.
E. R. Sasscer, Washington, D. C.
W. J. Schoene, Blacksburg, Va.
W. M. Scott, Washington, D. C.
L. M. Smith, Blacksburg, Va.
T. E. Snyder, Washington, D. C.
L. A. Stearns, Leesburg, Va.
T. B. Symons, College Park, Md.
F. M. Trimble, Primos, Pa.
G. W. Underhill, Blacksburg, Va.
R. H. Van Zwaluwenberg, Hagerstown, Md.
Joe S. Wade, Washington, D. C.
W. R. Walton, Washington, D. C.
J. L. Webb, Washington, D. C.
L. P. Wehrle, Ithaca, N. Y.
W. B. Wood, Washington, D. C.

President E. D. Ball: You will please come to order. The first business on the program is the report of the Secretary.

REPORT OF THE SECRETARY

The total membership of the Association at the time of the last annual meeting was 501, divided as follows: active 145, associate 306, and foreign 50. At that meeting four associate members resigned, and twenty-two were transferred to active membership. During the year four associate members have been dropped from the rolls and three active, seven associate and two foreign members have died. Seventy-one associate members were elected at the Pittsburgh meeting.

The present membership totals 553, divided as follows: active 164, associate 340, and foreign 48. The net gain for the year has been 50 members.

On July 15, 1916, Mr. A. T. Gillanders, one of our foreign members, was stricken with heart failure and died at Oxford, England.

This information did not reach the Secretary until April of this year which accounts for the lateness of this notice.

On February 17, 1918, Charles A. Hart died at his home at Urbana, Ill. He had been associated with the Illinois State Laboratory of Natural History and the Illinois State Entomologist's office for many years, and was one of our older active members.

On March 13, 1918, W. H. Harrington died at Ottawa, Canada. He has been an associate member for many years and his systematic work in Hymenoptera and Coleoptera was of recognized merit.

On April 11, 1918, Lieut. Vernon King, an associate member of this Association, was killed in an air battle in France when the machine in which he was flying with a pilot was attacked by three enemy scout machines. He was formerly employed by the United States Bureau of Entomology at Wellington, Kan., and was highly respected by all who knew him.

He joined the British Army soon after the Great War began and saw service in the Dardanelles campaign and later in France.

On July 4, 1918, Lieut. John W. Bradley, an associate member, died as the result of an aeroplane accident at Dayton, Ohio. Prior to the war he was an assistant at the Gipsy Moth Laboratory of the Bureau of Entomology, Melrose Highlands, Mass. He had completed his training and received his commission shortly before the accident occurred. He was a young man of great promise.

On July 21, 1918, Lieut. W. H. Hasey, an associate member, was killed in action in France while serving in the United States Infantry. He was a young man who had been trained in entomology at the Massachusetts Agricultural College, and carried on spraying and tree surgery work in Eastern Massachusetts.

On August 25, 1918, Dr. G. Leonardi, of the Royal Scuola di Agricoltura, Portici, Italy, a foreign member, died at Ventimiglia, Italy. He was well known for his work on Coccids.

On September 10, 1918, H. O. Marsh, an active member, died at Chester, N. J. Most of his active work was conducted for the Bureau of Entomology and many of his publications were issued by that Bureau.

On September 26, 1918, S. C. Vinal, an associate member, died of pneumonia at Cambridge, Mass. He was just beginning a career which promised a brilliant future as an entomologist.

On October 8, 1918, A. D. Duckett, an associate member, died of influenza. He had been employed several years by the United States Bureau of Entomology.

On November 2, 1918, Frederic Knab, an associate member, died at Washington, D. C. He had been an assistant in the Bureau of Entomology for many years and was custodian of the Diptera in the United States National Museum.

His work on Diptera, particularly Culicidae, is well known to all entomologists.

On December 15, 1918, Lieut. A. H. Jennings, an active member, died at Camp Shelby, Miss., from injuries by being knocked down by an automobile. He had done much valuable work on mosquitoes both in the United States and in the Canal Zone, Panama.

The Pacific Slope Branch held its third annual meeting March 28–29, 1918, at the branch laboratory of the California State Insectary at Alhambra, Cal. Twenty-nine members and visitors were present. An excellent program was presented and an opportunity given for field inspection of entomological work. The proceedings were published in the June number of the Journal of Economic Entomology.

During the past year there has been a moderate sale for Banks Index to the Literature of Economic Entomology. It has been necessary to bind 300 additional copies in order to meet future calls and this expense, together with postage and insurance, has been met from 1918 sales. The financial statement shows a balance of $46.92 in the treasury to the credit of this account.

Three hundred dollars is still due the Association fund on account of the Index, but it is expected that this can be reduced somewhat during the coming year.

At the last annual meeting it was voted that the dues of officers and enlisted men, members of this Association in the United States or allied armies or navies, be remitted until the close of the war.

This has been done in a few cases, but owing to the uncertainty concerning the status of many of the men, and contradictory reports that were received it was impossible to conform to the instructions of the Association in every case. The proper adjustment will be made with all our soldier and sailor members and each will receive full benefit of the action of the Association.

Remission of dues does not include subscription to the Journal of Economic Entomology.

The Secretary was also instructed to prepare an honor roll. It has been impossible to do this with any degree of accuracy. The following roll (see page 126), is submitted. It is doubtless imperfect in some respects, but is the best that can be done under the circumstances.

The Journal of Economic Entomology

There has been a considerable reduction in the subscription list of the Journal during the past year, and it has been necessary to curtail expenditures as much as possible in order to prevent a large deficit.

During 1917, 572 pages were published in the Journal; during 1918, 494 pages were published. Even with this reduction in the amount of printing, the income from the Journal has not been sufficient to pay expenses. The available balance at the end of the year 1917 has been exhausted and it has been necessary to use Association funds in order to keep the bills paid. At the annual meeting at Pittsburgh, the Secretary was authorized to transfer, not to exceed $200, from the Association funds for use in connection with the Journal. It has been necessary to do this and $105.09 of this amount has been expended. Prices on nearly everything in connection with publishing the Journal have increased greatly. The cost of printing was increased early in the year and a further increase of 25 per cent went into effect October 1. Printing is the largest single item of expenditure, but the cost of mailing, cost of postage, and nearly everything else has been advanced during the past year. It is impossible to attempt to meet these expenditures for the coming year by increasing the subscription price of the Journal for the year 1919, as it is necessary to quote prices to subscription agencies and dealers five or six months prior to the beginning of the year and after these prices are fixed and published, it is impossible to revise them. For the coming year it will be necessary to reduce the size of the Journal and in all probability draw on Association funds to make up the deficit.

Beginning with the year 1920, the subscription price of the Journal should be increased by not less than 50 cents or more than $1 per year. The exact rate should be decided before July 1, 1919. This will give time to determine whether production prices will be maintained, advanced or decreased, as conditions become more normal.

Association Statement

Balance in Treasury, December 7, 1917		$588.87
By amount received from dues, 1918		508.00
By amount received from interest in Malden National Bank		13.20
By amount received from interest of $100 Liberty Bond		4.12
Paid stenographic report 1917 meeting	$91.76	
Buttons, 1917 meeting	10.73	
Postage	41.00	
Printing programs, etc	77.24	

Telegraph and express	$1.29	
Transfer to JOURNAL fund	200.00	
Clerical work, Secretary's office	35.00	
One-half salary of Secretary	50.00	
Returned check	2.00	
	$509.02	
Balance, December 10, 1918	605.17	
	$1,114.19	$1,114.19
Balance deposited as follows:		
Melrose Savings Bank	$157.42	
Malden National Bank	447.75	

JOURNAL STATEMENT

Balance in Treasury, December 7, 1917		$189.27
By amount received from subscriptions, advertising, etc., 1918		2,063.58
By amount received from Association account		200.00
By amount received as interest on bank deposit		5.13
Paid for stamps	$52.42	
express	2.68	
printing	1,872.84	
Telegraph	1.43	
Half-tones	135.15	
Miscellaneous supplies	3.00	
Insurance	20.55	
Clerical work, Editor's office	65.00	
Clerical work, Secretary's office	60.00	
Salary, Editor	100.00	
One-half salary of Secretary	50.00	
	$2,363.07	
Balance, December 10, 1918	94.91	
	$2,457.98	$2,457.98
Balance deposited in Malden, Mass., National Bank	$94.91	

INDEX STATEMENT

Balance in Treasury, December 15, 1917		$15.51
By amount received from sales to December 10, 1918		188.00
Paid for binding	127.89	
postage	10.00	
insurance	18.70	
	$156.59	
Balance, December 10, 1918, Deposited in Malden, Mass., National Bank	46.92	
	$203.51	$203.51

Summary

Balance on Index Account	$46.92
Balance on Journal Account	94.91
Balance on Association Account	605.17
One $4\frac{1}{4}$ per cent Liberty Bond	100.00
	$847.00

Respectfully submitted,

A. F. Burgess,

Secretary.

After a brief discussion it was moved that the report be accepted and the financial part referred to the Auditing Committee; also that the honor roll submitted by the Secretary be published in a prominent place in the Journal and that suitable mention be made of the services of other members of the Association, not in the Army or Navy, who contributed their efforts to win the war.

President E. D. Ball: The next report is that of the Executive Committee, but there is no special report to make. The place of meeting was changed by the American Association for the advancement of Science, consequently we thought it necessary to make a similar change.

Secretary A. F. Burgess: In connection with the changing of the place of meeting, I will say that late in the fall several members suggested that we hold an independent meeting at Cornell University on account of the probability that Baltimore would be crowded at this time. The Executive Committee decided, however, that it would be best to hold the meeting at Baltimore. Conditions have improved very much recently, and it is doubtless fortunate that this arrangement was made as it developed that Cornell University could not make convenient arrangements for holding the meeting during the vacation period. There is, however, a desire on the part of some of the members to hold a meeting at Ithaca when convenient arrangements can be made.

President E. D. Ball: The next on the program is the report of the Entomologists' Employment Bureau. (Dr. Hinds, who has charge of the Bureau was not present at the meeting, and his report did not arrive until after final adjournment, therefore no action could be taken on it. The report is inserted, however, to complete the record.)

REPORT OF ENTOMOLOGISTS' EMPLOYMENT BUREAU FOR YEAR OF 1918

During the past year the work of the Bureau has been much affected by war conditions. The drafts placed many of the men on our rolls in army service and thus reduced the number of eligible candidates for the few positions which were reported to us. The restrictions of war economies evidently reduced the number of positions for which candidates were sought. There has been a notable change in both these phases of our work since the middle of November.

During the past year fourteen (14) men have enrolled, including the reënrollments. Several men have been placed but we know that our record of placements is very incomplete.

Ninety-one (91) references have been made between possible employers and employees, and two hundred and ten (210) letters written in the Bureau work.

Financial Statement for Year of 1918

Receipts:		
Dec. 26, 1917, Cash on hand	$47.10	
1918 enrollments, fourteen, at $2.00	28.00	
Total		$75.10
Disbursements:		
April 9, 1918, Paid J. P. Bell (stenographer)	6.80	
Aug. 24, 1918, Post Publishing Co. (printing)	2.00	
Oct. 28, Paid C. E. Posey (stenographer)	11.20	
Dec. 21, Paid Mrs. J. W. Dooley (stenographer)	3.00	
Dec. 24, Paid W. E. Hinds, postage for year	6.30	
Dec. 24, Paid W. E. Hinds, entomologist for envelopes and second sheets furnished for year	2.50	
Total		31.80
Balance, cash on hand		$43.30

Respectfully submitted.

W. E. Hinds,
In Charge.

President E. D. Ball: We will now listen to the report of the Committee on Nomenclature.

REPORT OF THE COMMITTEE ON NOMENCLATURE

The Committee on Nomenclature has had nothing referred to it during the year, and no suggestions or requests have been made regarding the adoption or change of common names. The members of the committee feel, however, that considerable work should be done along this line in order to insure stability and uniformity in common names. For the purpose of making a slight contribution towards this end, the following names have been suggested by members of the committee, and the committee recommends their adoption:

Laspeyresia molesta Busck .... Oriental Peach Moth
Pyrausta nubilalis Hubn .... European Corn Borer
Rhagoletis cingulata Loew .... Banded Cherry Fruit-fly
Rhagoletis fausta O. S. .... Dark Cherry Fruit-fly

Respectfully submitted,

W. E. Britton,
Edith M. Patch,
Glenn W. Herrick,
Committee.

Report was accepted and the recommendations adopted with the exception of the tobacco worm, *Crambus* sp., which was referred back to the committee for further consideration.

President E. D. Ball: The report of the Committee on Index to Economic Entomology will now be in order.

REPORT OF THE COMMITTEE ON THE PUBLICATION OF THE INDEX OF AMERICAN ECONOMIC ENTOMOLOGY

The successful completion of the Index for 1905 to 1914, at a tota cost of $1,212.90, was reported at the last meeting, at which time there was a balance against the work, after deducting receipts from sales, of $284.49. The Secretary of the Association, under date of December 9 last, states that thirty-seven copies have been sold and paid for during the year and as the stock of bound copies on hand was running very low, 300 more copies were bound. He adds that the expense of binding, insurance and postage has made it impossible to reduce the $300 outstanding which was borrowed from the Association funds. There is, however, to the credit of the index fund at the present time $46.92 and if a reasonable number of sales can be made during the coming year, this debt can be considerably reduced.

A recent letter from Doctor Howard, Chief of the Bureau of Entomology, states that he and a number of other men in the Bureau, think it very desirable that a five year Index, covering the years 1915 to 1919, should be prepared. Furthermore he will arrange to have the compilation made and as the value of the Index depends to a very considerable degree upon the promptness of its publication, it seems advisable that the compilation be commenced early enough so that the Index will be complete or practically so by the end of the next calendar year, thus making it possible to issue the volume in March or April, 1920.

This Index covers a five-year period and in order to be on the safe side, it has been estimated that there would be about three fourths as many references as in the volume covering the preceding decennium. This would make a work of about 250 pages. Tentative figures by the printer, based on current prices, indicate that the cost of the completed work would be approximately the same as that of the other volume; in other words, the advance in prices would be approximately offset by the smaller size of the volume.

The committee therefore recommends that it be continued and authorized to start the work in 1919, along substantially the same lines as were followed in the preparation of the preceding Index, and that the editorial board of the Journal of Economic Entomology be authorized, in its discretion, to proceed with the publication of the Index and to fix, as heretofore, the price of copies.

Respectfully submitted,

E. P. Felt,
A. F. Burgess,
W. C. O'Kane,
W. E. Britton,
W. E. Hinds,
Committee.

On motion the report was accepted and the recommendations adopted.

President E. D. Ball: The next report is that of the Committee on War Service.

REPORT OF THE COMMITTEE ON WAR SERVICE BY ENTOMOLOGISTS

Your Special Committee appointed January 2, 1918, to bring to the attention of the federal authorities resolutions of the Association tendering to the War Department the technical services of entomologists in connection with camp sanitation, especially in the prevention of insect-borne diseases, begs to report that we met first in Washington, January 9–12, coming into conference with officers of the War Department most immediately responsible for the control of camp sanitation, submitting to the Department through them the resolutions passed by you at your Pittsburgh meeting, and taking such further steps towards realizing the purpose of these resolutions as seemed possible at the time; that we met again in Washington, April 5, to complete our arrangements with the Department; and that our business since that time has been conducted by correspondence only.

It appeared to us in the beginning that entomologists might be of important service to the armies of the United States in time of war by accepting such positions as might be offered them in the U. S. Sanitary Corps as experts in the study and control of insect pests, especially those which are carriers of contagious disease to our troops in camp and field; by acting as advisers to the sanitary officers of camps and cantonments in their respective territories; and by engaging, as their other employments might permit, in a careful investigation of sanitary problems in which infestation by insects was an important factor.

At our first meeting we had a conference with Doctor Howard and examined the correspondence which he had already had with the Surgeon-General's office relative to the appointment of entomologists to positions in the Sanitary Corps. The committee planned at the outset to coöperate with the U. S. Bureau of Entomology, which, by reason of its location, affiliations, and opportunities for personal communication and conference, was in position to advise and negotiate and to make recommendations, both general and specific, to the War Department. Indeed, the Bureau had already done much to influence the policy of the Medical Department with respect to the appointment of entomologists as sanitary officers.

Although the responsible officers of the Medical Department were by no means a unit as to the need of entomologists in official relation to army sanitation, some of the more important of them being, indeed, evidently of the opinion that the medical officers of the Sanitary Corps were, or would presently become, entirely competent to handle insect problems in a practical way without expert aid from entomologists, there were still enough whose minds were open to conviction to give the Bureau of Entomology a fair opportunity to bring fact and argument to bear, with the result that E. H. Gibson, R. Gies, W. B. Herms, A. H. Jennings, and D. L. Van Dine were commissioned as captains in the Sanitary Corps, L. H. Dunn, and W. H. White as lieutenants in that corps, and G. F. White as a captain in the Medical Corps. Several entomologists were taken into the army and given non-commissioned positions, six of them as sergeants and one as a corporal. In the navy John W. Bailey was sent to the Navy Medical School and recommended for a commission, but was later transferred to the army and would have received a commission within a few days except for the signing of the armistice; and O. H. Basseches, who was in the Officers' Training School, would have received a commission in the Veterinary Corps except for the same reason. Several entomologists who applied for service in the Medical Corps were sent to the Yale Army Medical School, and were being trained for possible commissions in the Medical Corps when hostilities were terminated. One member of the Marine Corps, C. D. Duncan, was promoted to pharmacist's mate and had charge of all the entomological sanitation at Quantico; and five privates were assigned to entomological sanitary work in their camps.

The Bureau has also maintained, throughout the period of the war, thorough coöperation with the Surgeon-General's office in the matter of *experimental* work on insect problems. Practically all of the work on the body-louse has been conducted in the Bureau or through a committee of the National Research Council of which Doctor Howard is chairman; and reports of these investigations have been sent, as fast as ready, to the Surgeon-General's office. By direction of the Surgeon-General, arrangements were made with Major F. B. Granger for coöperative experiments in certain phases of the itch-mite problem. A large part of this investigation was carried on in coöperation with the Quartermaster's Department, and, as a result, extensive reports were made on the value of laundering and dry-cleaning processes against the body-louse. A very promising coöperation was established with several officers of the Chemical Warfare Service. In one line of research experiments were made to learn the fumigation value of all gases used in chemical warfare, and in another, to determine the effect in controlling vermin of substances used to protect the body against the poisonous gases.

Indirectly the Bureau was asked to render considerable service to officers handling sanitary problems by means of the duplicated proceedings of a class formed for the study of the entomology of disease, hygiene, and sanitation. Copies of these proceedings were sent to every camp library in the United States at the request of the Camp Library Association, and were also sent personally to many officers.

In its own direct operations your committee was somewhat hampered by the undeniable fact that, although representing an important national association, we were, in a military sense, simply citizens offering assistance to army officers presumably competent to the discharge of their duties, however special and numerous these might be, and by the further fact that we had in the beginning no definite information of conditions existing at that time in our own camps and cantonments which we could submit as convincing evidence that the services of entomologists were actually needed in the American Army. It seemed, therefore, to be our first duty to arrive, if possible, at a knowledge of these conditions, and we proposed a system of unofficial visits by the entomologists of certain selected states to camps and cantonments within their territories, with a view to ascertaining whether insect problems were really being handled successfully, and to serving as unofficial advisers to the medical officers in charge if occasion were found for such advice. We had in view, also, the fact that a critical inspection of entomological conditions in the neighborhood of military establishments was an immediate duty of entomologists interested in the protection of the health of the people in their states against insect-borne diseases, and for this no special authorization was needed. We proposed, of course, to send to the Surgeon-General informal reports of observations made and recommendations which seemed to be called for.

Through the willing and interested courtesy of Colonel F. F. Russell, of the U. S. Medical Corps, who wrote us under date of February 23, "I think that we all agree that a survey made in this way is a very desirable and satisfactory solution of one of our difficulties," an arrangement of this character was made, and letters of introduction were given, at our request, to the various medical officers concerned, of which the following is an example:

From the Surgeon-General, U. S. Army

To The Division Surgeon, Camp Sherman, Ohio

1. This will introduce to you Professor Herbert Osborn, of Ohio State University, Columbus, Ohio. Professor Osborn is one of the best known economic entomologists in the country. It is believed that direct coöperation between you and Professor Osborn will result in the prompt correction of sanitary difficulties due to insect pests,

especially since Professor Osborn has, through his state connections, considerable power and authority over extra-cantonment conditions which cannot be reached directly by you.

By direction of the Surgeon-General:

(Signed) F. F. Russell,
Colonel, Medical Corps, U. S. A.

It was our intention to choose in the first instance a few typical, widely separated, camps and cantonments such as might be supposed to give us a fair idea of conditions throughout the country, and letters were requested for entomologists in the states of Arizona, Colorado, Alabama, Illinois, Ohio, New York, and New Hampshire. Owing no doubt to the terrific pressure on all military offices in Washington at the time, the letters called for were not actually issued until the last days of May, and reports of surveys were received by the committee at various dates from June 8 to August 9, and these were forwarded to Washington soon thereafter. In the meantime, the vacation season had so far dispersed the official entomologists, including the chairman of this committee, that no further progress was made on this program.

We scarcely need say that the visiting entomologists were cordially welcomed in every case; that every facility and assistance was rendered them in making their observations; and that their comments and suggestions, when matters of any importance came to light, were received with evident appreciation of the service rendered. Full reports were received by us concerning seven different camps, and brief general statements concerning two others.

It was evident from these reports that the entomological problems relating to the camps and cantonments were being handled much more successfully than those relating to adjacent areas outside. There was little found, indeed, concerning interior conditions to which serious exception could be taken. In one southern camp houseflies were common in mess-halls and kitchens, although all buildings had been thoroughly screened, the trouble here being due to an imperfect fitting of the screens to window openings, and to an unsuspected breeding place of flies in livery stables about a mile away, the surroundings of which were not as clean as they should have been although all manure was being removed from the stables every day. In one or two camps somewhat infested by lice and other parasites, the officers were taking the proper steps to abate the nuisance.

The following are fair examples of the reports received, one relating to Camp Sherman, in Ohio, and the other to Camp Devens, in Massachusetts:

Camp Sherman.—"As I had letters to Surgeon Robinson from Dr. Freeman and, to Colonel Allen, Division Surgeon, from the Surgeon-General's office, I received a very cordial welcome from these officers and believe that the information I secured is thoroughly reliable and that we can depend upon the men in charge of sanitation at the camp to coöperate in every practical way in the matter of utilizing any information that we may be able to furnish concerning most effective plans for insect control. In this first visit I think the main accomplishment was the establishment of cordial relations as a basis for coöperation in the future.

"From all of the facts that I learned, it appears that the health conditions in this camp have been excellent and there have been practically no cases of disease which could be attributed to insect carriers. Typhoid has been practically eliminated as a result of inoculation, but the disease is more or less prevalent in the vicinity of the camp and the public health service in coöperation with the State Board of Health is making a vigorous campaign for the reduction of flies and the elimination of all possible sources of fly-breeding and contamination.

"The camp itself has disposed of stable waste very effectively by daily distribution to the surrounding farms—so effectively, indeed, that it was said that there was more difficulty in disposing of the stable wastes from the city proper. The local officer considers that they have this fairly well in hand now, and expects improvement as they get their organization more effectively at work.

"Apparently they have had no annoyance from mosquitoes. There is no malaria in the locality nor has there been for many years. However, they recognize the possibility of malarial cases and the need of guarding against *Anopheles*. The mosquito situation will need some attention, but, considering the conditions, I believe the local authorities are fully justified in putting their main effort at present on the suppression of flies rather than undertaking any extensive operations against the possible mosquito-breeding localities. In case any injury comes from this course it will be desirable either to provide drainage or else to keep the ponds and canal pockets filled with water and stocked with fish or mosquito-destroying insects to avoid danger from this source.

"No rats have been troublesome at the camp, and were reported not abundant in the town. No flies, body-lice, chiggers, 'punkies,' buffalo-gnats, or other pests have occasioned trouble so far. On the whole, I think the sanitary conditions may be considered in good shape, and the officers in charge are exceptionally energetic and efficient in their operations."

Camp Devens.—"I visited this camp five times in the course of the summer, and each time have looked over conditions in a general way.

"The reception accorded me by the Division Surgeon and his assistants had been exceedingly friendly. There was an evident desire on the part of the officers to take full advantage of any help that might be offered them and a full willingness to explain in detail the measures that they were carrying through to control insect pests within the camp. One could not ask for a more cordial and open-minded reception.

"Camp Devens is situated in a sandy region made up of many small knolls originally covered, for the most part, with small, scrubby tree growth. There are several small ponds within the limits of the camp, and along one border is a river which, so far as I have observed, has slow movement. Most of the area has excellent natural drainage, with the exception of some of the ponds and especially the borders of the river.

"The sanitary officers carried out considerable drainage measures, especially in some wet areas adjacent to the base hospital and a similar area near the large parade ground. Drainage of a rather stagnant pool, somewhat filled with brush, was not undertaken and probably was not feasible. Drainage of the extensive stagnant water along the border of the river could not be undertaken, since there was no fall. Apparently, conditions were such that mosquitoes might become a serious nuisance, but throughout this season very few mosquito larvæ could be found in any of the ponds or in the stream. Enlisted men with whom I talked said that they were not bothered at all with mosquitoes. In the course of the summer the camp received a detachment of more than two thousand negroes from the south, and examination by the division surgeon's officers showed that a large proportion of these negroes were carriers of malaria. For this reason I feared that there would be danger of an outbreak of malaria in the camp if *Anopheles* should show up, but nothing of the kind took place.

"Considerable oiling was done by sanitary squads. Oil was applied by knapsack pumps and by drip cans. However, to attempt to control the mosquitoes by oiling in some of the swamp areas, especially along the river, would be difficult.

"The fly proposition was handled carefully by the sanitary officers. Garbage was removed daily to a station at one margin of the camp, where the cans were emptied and washed. The garbage from the emptied cans was hauled away by a contractor. Facilities for thoroughly cleaning the cans were inadequate. They were supposed to be cleaned with scalding water, but the boiler for providing the hot water was too small.

"Outside each mess-hall garbage cans were placed within screened cages. Most of these cages were provided with fly-traps. In the opinion of one of the assistants attached to the division surgeon's office, garbage was handled more satisfactorily when the cans were placed on an open platform, provided the cans are removed daily. On the open platform there is less opportunity for bits of garbage to remain unnoticed in corners. Also, in his experience, screened receptacles for garbage soon ceased to be fly-proof.

"Horse manure was collected daily; was carted to a loading station near the camp and was there loaded into freight cars and hauled away. For the most part the stables were kept clean. There was no evidence of extensive breeding of flies in stable manure.

"Occasionally men were received in the cantonment who were infested with body-lice, but apparently such cases were always detected and the lice destroyed. There

was no general infestation of body-lice at any point in the cantonment, so far as I could learn.

"Bedbugs became a nuisance in certain officers' quarters, and were difficult to control because of the type of building."

The control of outside conditions usually required the coöperation of local authorities or state boards of health, and this was sometimes obtainable and sometimes not. In one of our Illinois camps, for example, a prairie stream which carried away camp sewage was regularly policed and all the farm premises within half a mile were kept quite clean of breeding places for flies; in another all waters in which mosquitoes might breed were regularly oiled by sanitary squads sent out from the camp; but in a third no attention whatever had been paid to the immediate environment, although the camp had been established within a quarter of a mile of an extensive swamp in which mosquitoes, including *Anopheles*, began to breed in immense numbers as soon as the season opened, neighboring outhouses were in filthy condition, and a sawmill employing a number of workmen near the camp was without toilet facilities of any kind. Even here, however, there were no untoward consequences, an unusually long drouth drying out the swamp and no cases of disease traceable to house-flies occurring.

It was in the improvement of these outside conditions that our entomologists might have been most active and useful; and if the war had continued we should doubtless have brought this fact clearly to your notice, with a view to a plan of more general and effective coöperation another year.

The subject of after-the-war work by entomologists lies, of course, outside the duty of this committee, but we take the liberty, nevertheless, of calling your attention to a discussion of it which appeared as an editorial in the December number of the Journal of Economic Entomology, and to express the approval of the committee as a whole of the suggestions made therein.

S. A. Forbes,
E. P. Felt,
W. C. O'Kane,
Committee.

Mr. E. P. Felt: Dr. Forbes, chairman of this committee, is unable to be present, but the report which he has drafted has been examined by the other members of the committee and with the exception of a few minor changes, is in the same form as he originally submitted it.

A general discussion of this report followed, and as there seemed to be work along war or after the war lines, that could be done, it was voted that the report be accepted and the committee continued.

President E. D. Ball: We will now listen to the report of the Committee on Entomological Investigations.

Mr. W. J. Schoene: A circular letter has been sent to the entomologists and as soon as returns come in, these will be compiled and copies forwarded to the members. By vote of the Association the report was adopted.

President E. D. Ball: We will now listen to the Committee on the Proposed Amendment to the Constitution.

REPORT OF THE COMMITTEE ON PROPOSED AMENDMENTS TO THE CONSTITUTION

The chairman of the Membership Committee of last year submitted proposals for the amendment of the constitution which would result in reclassifying the membership and provide, in addition to classes already recognized, for the election of fellows and honorary fellows. The principal object of the proposed change was to provide for the admission to active membership of a considerable number now listed as associate members. The committee, in view of the somewhat unsettled conditions of the present, recommend that developments be awaited and action deferred.

Respectfully submitted,

E. P. Felt,
W. C. O'Kane,
J. G. Sanders,
Committee.

On motion the report was adopted.

President E. D. Ball: We will now take up any miscellaneous business.

Mr. T. J. Headlee stated that he was opposed to decreasing the size of the Journal and suggested that a committee be appointed to secure additional finances so that the present size could be maintained.

Secretary A. F. Burgess stated that under ordinary conditions the Journal had been able to meet its expenses, but with the increased cost of everything connected with its makeup during the past two years, it was not possible to finance the Journal upon its present resources. The rates for 1919 had been made last June to subscription agencies and it was therefore impossible to increase the price for 1919. The desired result could be brought about by increasing the subscription list or by decreasing the pages of the publication and drawing funds from the treasury of the Association. The subscription price for the year 1920 should be increased.

Mr. E. P. Felt stated that if there were enough members willing to subscribe $10 apiece, the 1919 issue could be carried through without decreasing the number of pages, but arrangements should be made for increasing the subscription price for 1920. A motion was made that the Journal be kept at its present size.

President E. D. Ball stated that at the present time 88 members of the Phytopathological Society were each subscribing $10 per year for a period of ten years to finance their Journal and that the annual subscription to their Journal was $4. He expressed surprise that some of the active members of the Association were not subscribing for the Journal, and thought that all members should show their loyalty to the publication by supporting it at this time.

Mr. J. G. Sanders stated his belief that active members should subscribe.

Secretary A. F. Burgess remarked that there were a considerable number of both active and associate members who did not subscribe to the publication.

Mr. Raymond Osburn asked if it would not be well to make the dues include subscription to the Journal.

Secretary Burgess stated in reply that the reason for keeping the two accounts separate was because of the possible difficulty with the Postoffice Department in connection with the second-class mailing privilege.

Mr. Osburn stated that he had dealings with another publication and that they had no trouble along this line. He further stated that another society with which he was connected had published a journal which cost more than their available income, but it had been found quite easy to secure contributions from the members of the society so that the indebtedness was paid off.

Mr. T. J. Headlee stated that he was strongly opposed to any action which would compel members to subscribe to the Journal if they did not wish to do so, and thought that the publication should be so valuable that all would be anxious to support it.

Upon motion it was voted that the Journal be kept at its present size for the coming year, and that a committee of three be appointed by the President to devise means of carrying this into effect.

At the Thursday afternoon session during the consideration of the President's address, a motion was made by T. J. Headlee that a Standing Committee on Entomological Policy of ten members be appointed, the terms of office being so arranged that two should retire each year and their successors be elected for a term of five years. After general discussion this motion was laid upon the table for consideration at the final business session. Discussion of this motion by various members will be found under the discussion of the Presidential address. The following committees were appointed by the President:

Nominating Committee.—C. P. Gillette, J. G. Sanders and E. P. Felt.

Committee on Resolutions.—W. D. Pierce, W. J. Schoene and E. C. Cotton.

Auditing Committee,—W. R. Walton and J. S. Houser.

Committee on Journal of Economic Entomology.—T. J. Headlee, Herbert Osborn and W. E. Britton.

Before adjournment the President appointed Mr. C. P. Gillette to fill the vacancy on the Council of the American Association for the Advancement of Science, due to the absence of Mr. R. A. Cooley. A general discussion followed in connection with recommending members of this association to become Fellows in the American Association

for the Advancement of Science. It was voted that the representatives of this association on the council of the American Association for the Advancement of Science be requested to present to that association the names of active members whom they consider should be made fellows.

At the Friday morning session during the discussion of the paper on the European Corn Borer, the following motion was made and unanimously carried: That this Association endorses the utmost possible measure of eradication of the European Corn Borer and further endorses the proposition of asking Congress for sufficient appropriation to undertake immediately a competent campaign of eradication, under Federal direction. As this was a joint session of the Association and the Section on Horticultural Inspection, it became necessary to nominate a Chairman of the Section for the year 1919. Mr. E. C. Cotton was nominated for Chairman and Mr. J. G. Sanders was elected Secretary of the Section.

At the final session, the following business was transacted:

President E. D. Ball: I will now call for the report of the Committee on Auditing.

REPORT OF AUDITING COMMITTEE

The Committee on Auditing has examined the books of the Secretary and found the accounts to be correct.

J. S. Houser,
W. R. Walton,
Auditing Committee.

By vote of the Association the report of the committee was accepted.

President E. D. Ball: We will now hear the report of the Committee on Resolutions.

REPORT OF THE COMMITTEE ON RESOLUTIONS

The Committee on Resolutions has the honor to report the following resolutions:

We believe that our Association and our profession has just crossed the threshold of a new era in scientific effort. As we look back over the record of the past year we find that our numbers have been decreased by several deaths, some in the service of our own glorious nation, and some in the service of our great Allies, while others have died in the simple performance of their life-time duties. We glory in all that they have done for our science, and in these few words wish to pay tribute to each of them for the work that he accomplished.

We desire to call attention to the faithful services of our Association's officers of the past year, and the welcome address of our retiring President; to the courtesies of the Johns Hopkins University, and the Committee of Arrangements of the Association.

Finally we look forward toward the building up of a firm foundation for economic entomology.

Therefore be it resolved:

1. That the American Association of Economic Entomologists, deeply grieved over the loss of its associates, Capt. Allen H. Jennings, Lieut. Vernon King, Lieut. J. W. Bradley, Lieut. W. H. Hasey, A. T. Gillanders, Dr. G. Leonardi, Chas. A. Hart, W. H. Harrington, H. O. Marsh, S. C. Vinal, F. Knab, and A. B. Duckett, does take this occasion to express to the world and to their families the esteem in which they were held.

2. That we are proud individually and collectively of every man who has served our nation or our Allies in the great struggle for freedom, no matter what may have been the particular field of action which befell him. Each did his part to the best of his ability.

3. That we as entomologists realize that our science is so intimately related to many other sciences and professions as to require frequent contact, and are determined that we will direct our efforts more and more toward obtaining effective coöperation with all other associated and interested groups of workers in all our problems.

4. That the science of entomology requires greater coördination in all its branches; and that we do hereby propose tentative discussion with other entomological organizations throughout the world, with the ultimate purpose of a world-wide union of entomological effort.

5. That a change is desirable in the Constitution of this Association, so that we may have a more stable organization and may develop year by year deeper seated general policies for our science.

6. That for the present the most available method of accomplishing the three resolutions above is the formation of a committee on policy, to be composed each year of the President, Secretary of the Association, the Editor of the Journal and five members elected for five years each, one retiring each year; that the committee as initially composed contain one each elected for terms of one, two, three, four and five years; that this committee on policy have as its functions the directing of all policies of the Association and its various undertakings, the formulation and fostering of great entomological policies for the profession, and the working out of a more perfect coördination of scientific effort among entomologists and between entomologists and other professions; and finally that this committee on policy become by constitutional amendments an integral part of the Organization.

W. Dwight Pierce,
W. J. Schoene,
E. C. Cotton,
Members of Committee.

Mr. W. D. Pierce: I have two motions to put before the house at the proper time in order to make these resolutions effective.

By vote of the Association the report of the committee was adopted.

President E. D. Ball: We will now listen to the report of the Committee on Membership.

REPORT OF COMMITTEE ON MEMBERSHIP

In the report of the Membership Committee presented at the New York meeting of this Association, it was recommended that the Committee prepare a statement quoting that part of the constitution referring to membership, together with the records and the minutes of other action that the Association has taken from time to time,

relating to qualifications for membership and in addition, any further statement that may be necessary to clearly interpret the existing policy of the Association as to standards of membership, with the intent that this statement, after consideration by the Association, be printed on the back of the blank application for associate membership.

In response to the above request your committee submits the following statements:

Article II of the Constitution of the American Association of Economic Entomologists reads as follows:

Section 1. All economic entomologists, horticultural or apiary inspectors, employed by the General or State Governments, or by the State Experiment Stations, or by any agricultural or horticultural association, and all teachers of economic entomology in educational institutions and other persons engaged in practical work in economic entomology, may become members.

Section 2. The classes of membership shall be active, associate and foreign. Active membership shall be conferred only on persons who have been trained in entomological work and whose practical experience or published papers have evidenced their ability to conduct original investigations in economic entomology.

Section 3. Associate membership may be conferred on persons who have done general or practical work in entomology and who have by published papers or otherwise, given evidence of their attainments in such work.

Section 4. Foreign membership shall be honorary and shall apply only to members residing outside of the United States and Canada.

Section 5. Associate and foreign members shall not be entitled to hold office or to vote.

Section 6. Membership, other than foreign membership, may be conferred at any regular meeting by a two-thirds vote of the members present upon recommendation of the Committee on Membership, after a regular application endorsed by two active members has been filed with the Secretary.

Section 7. Foreign members may be proposed in writing by any active member and their names shall be acted upon by the Committee on Membership and the Association, as in the case of other members.

The past policy of the Association has been to admit to associate membership anyone who occupies some position in economic entomology and who is vouched for by two active members, and it is desirable for all associate members who seek advancement to active membership to submit to the committee a statement relative to their education, experience, and publications and when possible to likewise submit published papers that the committee may be in a position to carefully consider promotions. It is further suggested that active members aid the committee by recommending such associate members as they deem worthy of advancement and in so doing to submit data to enable the committee to act intelligently on the application, such nominations to be made at least three months prior to the annual meeting.

It has heretofore been the policy of the Association to elect to active membership from the list of associate members only.

The committee understands that as a general rule at least, active membership in the American Association of Economic Entomologists should be limited to those doing enough individual teaching or practical work so that economic entomology occupies a considerable share of their time and it can be no reflection upon anyone if he be denied membership simply because his activities are along other lines. Your committee has been governed to a certain extent by a ruling of the American Association for the Advancement of Science which is to the effect that members elected to active membership in our Association will become eligible to fellowships in the American Association for the Advancement of Science so long as we continue to be careful in the selection of our active members.

Foreign membership shall be honorary, according to the constitution, and nominations for foreign membership, together with full information concerning the publica-

tions and other qualifications of the nominee shall be filed with the chairman of the committee at least three months before the annual meeting.

The following members are recommended for advancement to active rank:

A. C. Baker
A. W. Baker
M. W. Blackman
W. H. Brittain
A. E. Cameron
G. C. Crampton
William Davidson
I. W. Davis
H. F. Dietz
R. W. Doane
H. E. Ewing
H. Fox
Philip Garman
Hugh Glasgow
J. E. Graf
Geo. P. Gray
P. A. Glenn
C. H. Hadley, Jr.
L. Haseman
W. P. Hayes
J. R. Horton
D. W. Jones
T. H. Jones
W. V. King
H. H. Knight
G. H. Lamson, Jr.
M. D. Leonard
Q. S. Lowry
A. L. Lovett
P. Luginbill
L. S. McLaine
A. L. Melander
F. H. Mosher
F. B. Milliken
H. Morrison
J. A. Nelson
Raymond C. Osburn
H. T. Osborn
R. R. Parker
T. H. Parks
A. Peterson
C. H. Popenoe
C. H. Richardson
W. S. Regan
L. P. Rockwood
W. A. Ross
A. F. Satterthwait
E. H. Siegler
L. B. Smith
J. N. Sumners
E. H. Strickland
W. B. Wood
M. P. Zapp

The following are recommended to associate membership:

Charles S. Beckwith
J. C. Bridwall
H. M. Brundrett
A. B. Black
C. P. Clausen
Mitchell Carroll
T. H. Cutrer
D. L. Dolbin
P. W. Fattig
C. L. Fluke, Jr.
W. T. Ham
M. E. Kimsey
A. O. Larson
G. M. List
D. B. Mackie
D. E. Merrill
Shonosuke Nakayama
J. H. Newton
H. R. Painter
H. B. Parks
D. B. Penny
F. W. Poos
B. A. Porter
J. M. Robinson
H. J. Ryan
R. R. Reppert
R. C. Smith
O. I. Snapp
Antony Spuler
B. G. Thompson
R. C. Treherne
A. W. Young
F. N. Wallace
E. E. Wehr
L. P. Wehrle
G. W. Underhill
James Zetek

That W. O. Hollister be reinstated to associate membership.

The following members have sent in resignations and the committee recommends their acceptance: A. B. Champlain, B. P. Gregson, Simon Marcovitch, W. E. Pennington and J. M. Stedman.

Ten members elected a year ago have paid no dues and seventeen additional associate and one active member are in arrears. The committee recommends that these members be notified by the Secretary that failure to promptly pay back dues will result in their being dropped from the rolls of the Association.

The list of members recommended for promotion to active membership is considerably longer than at any previous meeting but the committee, after careful consideration of recommendations and data received, believes all are fully eligible. The committee has received data which have enabled it to consider the eligibles to better advantage than heretofore and it does not understand that the large number of promotions should be taken as a precedent and that in future years the number raised to active rank may, so far as at present determinable, be much reduced.

Possibly other members may be eligible to active membership this year, but it is often impossible for the committee to properly make selections except where complete data have been furnished. Requests for the necessary data were sent to every associate member of this Association and of the 349 members of this rank only 57 sent in the information requested. The committee wishes to again request members who desire to become active and who have not already sent in these data to do so in order that their names may be given the proper consideration next year.

Respectfully submitted,

J. J. DAVIS, *Chairman*,
W. E. BRITTON,
T. J. HEADLEE,
Committee.

By vote of the Association the report of the Committee was adopted.

MR. W. C. O'KANE: I move that the motion which was made yesterday concerning the proposed Committee on Policy be taken from the table. Carried.

MR. W. D. PIERCE: I wish to propose the following substitute motion:

That a Committee on Policy be formed to consist of the President, Secretary and Editor of the JOURNAL, as ex-officio members, and five members to be elected for five-years terms, one retiring each year; and in order that this retirement be accomplished in the initial formation of the committee by electing one member for a full five-year term, one for four years, one for three years, one for two years, and one for one year; and that the duties of this committee shall be the originating and directing of all policies of the association and its various undertakings, the formulation and fostering of great entomological policies for the profession, and the working out of a more perfect coördination of scientific effort among entomologists and between entomologists and other professions."

It was voted that the motion of Mr. Pierce be substituted for the original motion, and it was then adopted.

PRESIDENT E. D. BALL: I will now call for the report of the Committee on JOURNAL OF ECONOMIC ENTOMOLOGY.

REPORT OF SPECIAL COMMITTEE ON THE JOURNAL OF ECONOMIC ENTOMOLOGY

Gentlemen of the American Association of Economic Entomology:

Your Special Committee on the Journal begs leave to report on the problem of financing the Journal as follows:

1. That the order of the Association to maintain the Journal during 1919 at its 1918 size be interpreted to mean "maintained in quality of printing, illustrations, and approximate matter contained but not necessarily at the same or a larger number of pages or the same quality of paper." That details of this interpretation be left to the business manager and editorial board who have so successfully handled these matters in the past.

2. That the $600 which the estimates show to be necessary in addition to funds already available, be raised in the following ways:

A. By a draft on the general funds of the Associations to the amount of $500.

B. By subscriptions among the membership of the additional sum of $100, which shall be raised as follows: and with the understanding that moneys as contributed shall be repaid in the form of dues and subscription to the Journal at the prices current for the years concerned, beginning next year:

a. By subscriptions during this meeting from the floor.

b. By subscriptions through correspondence.

3. That after expiration of present agreements the price of Journal subscriptions to non-members be raised fifty cents a year.

Respectfully submitted,

Thomas J. Headlee,
Herbert Osborn,
Committee.

At the request of the President the Secretary explained that it would probably be possible during the coming year to transfer $500 from the Association fund to the Journal fund. This would enable the Journal to be kept at its present size if $100 additional could be raised. The matter of fixing the price of the Journal for the year 1920 was fully discussed and it was voted that the report of the committee be accepted and the recommendations adopted with the understanding that the price of the Journal would be fixed by the executive committee.

President E. D. Ball: I will now call for the report of the Committee on National Museum.

REPORT OF COMMITTEE ON NATIONAL MUSEUM

The Committee on National Museum was appointed two years ago to study the conditions in the United States National Museum for the purpose of offering means for promoting and providing for adequate development of the division of insects. At our last annual meeting this committee reported on the needs of the Division of Insects, United States National Museum, and suggested means for promoting and assisting the work of this institution.

Owing to the unsettled conditions the past year, your committee has nothing further to report at this time.

Your committee recommends that a committee on National Museum be made a standing committee of this association, such a committee to keep in close touch with the entomological work of the United States National Museum, to foster its work, create sentiment towards the museum and in other ways make for the accomplishment of the ideals suggested in the last report of the present committee.

It is suggested that this committee consist of five members to be elected at each annual meeting, to hold office for a period of five years, and that they shall conduct their tasks in coöperation with the similar committee of the Entomological Society of America. Your present committee believes it desirable to make the committee representative of the United States and especially is this expedient if it becomes desirable for the committee to bring pressure on the legislative sources; and that the chairman of said standing committee hold office for a period of years since this would make for greater continuity of policy.

Respectfully submitted,

J. J. Davis,
E. P. Felt,
Herbert Osborn,
E. D. Ball,
R. L. Webster,
Committee.

Mr. A. L. Quaintance: I would like to inquire whether the Honorary Curator of Insects of the Museum will be an ex-officio member of this committee. I think the Bureau should be represented and I would like to ask whether this is the intention of the committee.

President E. D. Ball: It occurs to me that one of the purposes of this committee is to assist in securing funds and equipment for the Museum and it might not be advantageous to the Curator if he was a member of this committee.

By vote of the Association the report was accepted and recommendations adopted.

President E. D. Ball: I will now call for the nomination of Journal officers by the advisory committee.

Mr. C. P. Gillette: The advisory committee would nominate the present officers to succeed themselves for the ensuing year:

E. P. Felt, Editor.

W. E. Britton, Associate Editor.

A. F. Burgess, Business Manager.

By vote of the Association the recommendations were adopted.

Mr. W. D. Pierce: I wish to propose amendments to the Constitution. These amendments are designed to modify the Constitution so that the Committee on Policy which has been provided for the coming year may become a permanent organization at the beginning of next year.

PROPOSED AMENDMENTS TO THE CONSTITUTION

Article III

Section 1. Amend by striking out the second sentence which reads: "The above officers shall act as the Board of Directors and shall pass on any urgent matters that cannot be deferred until the annual meetings."

Add the following section:

Section 2. There shall be a Board of Directors to be composed each year of the President, Secretary, and Editor of the Journal, as ex-officio, and five members elected for five years each, one retiring each year. The Chairman shall be elected by the Board.

By-Laws

Article II. to be amended to read as follows:

Section 4. The publication of the Journal of Economic Entomology shall be entrusted to an Editor, an Associate Editor and a Business Manager, nominated by the Board of Directors. The members of this committee shall have an advisory relation to the above constituted Editorial Board.

Section 5. The Board of Directors shall have as its functions the originating and directing of all policies of the Association and its various undertakings, the formulation and fostering of great entomological policies for the profession, and the working out of a more perfect coördination of scientific effort among entomologists and between entomologists and other professions.

President E. D. Ball: This matter will come up for consideration at the next annual meeting and I will appoint the following committee to consider the amendments and report at that time: P. J. Parrott, W. A. Riley and George A. Dean.

Mr. W. E. Britton: As Associate Editor of the Journal I would like to ask all members to send in news items which may be appropriate to print as current news. It is difficult to secure these items, but if the members will coöperate this part of the Journal will be made more interesting.

President E. D. Ball: The report of the Committee on Nominations is now in order.

REPORT OF THE COMMITTEE ON NOMINATIONS

The Committee on Nominations begs leave to report as follows:

For President: W. C. O'Kane.
First Vice-President: A. G. Ruggles.
Second Vice-President: H. J. Quayle.
Third Vice-President: E. C. Cotton.
Fourth Vice-President: W. E. Britton.

Committee on Nomenclature, 3 years: Z. P. Metcalf.

Committee on Entomological Investigations, 3 years: P. J. Parrott.

Membership Committee, 3 years: E. R. Sasscer.

Council of the American Association for the Advancement of Science: H. A. Gossard and C. P. Gillette.

Director Employment Bureau: W. E. Hinds.

Advisory Board, Journal of Economic Entomology: W. J. Schoene and S. A. Forbes.

Committee on Entomological Policy: E. D. Ball, 5 years; Herbert Osborn, 4 years; W. D. Pierce, 3 years; J. G. Sanders, 2 years; and G. A. Dean, 1 year.

Committee on United States National Museum: J. J. Davis, Chairman, 5 years; V. L. Kellogg, 4 years; E. P. Felt, 3 years; Herbert Osborn, 2 years, and E. D. Ball, 1 year.

Respectfully submitted,

C. P. Gillette,
J. G. Sanders,
E. P. Felt,
Committee.

Mr. E. C. Cotton: I move that the report be adopted and the Secretary be instructed to cast the unanimous ballot of the association for the candidates named. Carried.

The ballot was cast by the Secretary and the officers named were declared elected by the President.

Secretary A. F. Burgess: I move that the next annual meeting be fixed at the same time and place as that chosen by the American Association for the Advancement of Science, unless it is deemed advisable by the committee on policy to change the time and place. Carried.

Secretary A. F. Burgess: I would like to say that the paper that has been passed around shows a subscription of $160 for the Journal fund. I think this indicates very strongly the interest of the members of the Association in their publication. Upon motion the meeting was adjourned.

PART II. PAPERS AND DISCUSSION

THE PRESIDENT'S ADDRESS

ECONOMIC ENTOMOLOGY—ITS FOUNDATIONS AND FUTURE

By E. D. Ball, *Ames, Iowa*

We are passing, today, through an epoch-making period. Decisions are being made and to be made, that will profoundly affect, not only the rights of the individual, but the destinies of nations and the entire superstructure of our political and social universe. We are witnessing, today, the birth of what one of our gifted leaders has christened—the modern world.

Our country has passed in a short year, from an isolated and indifferent entity, interested only in her own development, into a nation that has resolutely taken her place on the forum of democracy. Like a moth out of a chrysalis, she has broken her shell of contentment and

emerged, at first faltering and feeble, but rapidly gaining in strength, until her wings have expanded and she has risen and circled out over the fields of this world to be. The moth cannot fold her wings and return to the caterpillar stage on the single plant; she is now of the air and of life and must go on. Neither can our nation return to her isolation. She has taken her place in the lists as the champion of democracy—the establishment of the rights of the individual and the brotherhood of man, and as such, she must and should remain.

Our society has grown with the nation's growth, and has contributed to it. We have expanded as she has extended her domain and we must be prepared to go on with her, and take our place with her in the new order of things. If our society is to be true to its traditions, she must remain in an advanced position of leadership. This will require a broadening of our scope and interest, a strengthening of forces and ideals, a stronger administrative organization and a carefully chosen leadership to meet the requirements of our new and greater responsibility.

The Economic Entomologists are to be congratulated on the fact that they represent the oldest society in America organized for the promotion of an economic phase of agriculture. Thirty years ago, when this association was formed, agriculture was an art with slightly scientific ambitions, in a nation that was groping and struggling to find herself.

Thanks to the energy, enthusiasm and almost prophetic vision of the old warriors, Economic Entomology became crystallized and definitely established on scientific foundations long before our sister societies in Plant Pathology, Animal Nutrition, Agronomy, and Horticultural Science were even possible. We were extremely fortunate in the original band of warriors, crusaders after truth, whose self-sacrifice and devotion made this society possible. They were, for the most part, men whose love of nature had drawn them to the work and held them there despite discouragement, ridicule and lack of support. Truly they founded well, and on that foundation this association has grown in prominence and power, in numbers and influence, as well as in material prosperity, ever keeping pace with the progress of the nation.

The spread of the San José scale and the development of the nursery inspection laws in its wake, brought the entomologist into prominence, gave him financial support and opened the way for an extremely rapid development. No other of our sister societies has ever received such an impetus.

We wonder sometimes, however, when we compare the work of this society with its closest relative, the Phytopathologists, whether the wealth and power, brought to us by the apparent opportunity of the

inspection service, has not been our undoing—our destruction, rather than our salvation. Have not the opportunities been too great, positions too easy to obtain, educational standards and requirements too low for even the present good of the science, to say nothing of the foundations which we must build for the future? When we compare the relative training and preparations of Pathological and Entomological staffs in the same institutions and note that the Pathologists have about three Doctorates to the Entomologists' one, note in fact, that the Doctorate is as common in Pathology, as the Master in Entomology, we begin to feel anxious for the future of our beloved science. If we should go farther in our analysis and compare the type of work that is being put out today, by the two organizations, we might feel even more alarmed for the future of our science. We should not, however, be discouraged; we should rather read a message of warning and an opportunity for salvation. The Pathologists have been passing through the stages and struggles of the early days of this society. They are laying the foundations for their science. They are, today, winning the support of the people. They are small in numbers, but great in inspiration, in interest and zeal. They are better trained because the opportunities were few and the standards high. There has been little encouragement to enter the field, except for the real lover of the science. They are very largely a band of choice spirits. Today they are facing the problems that prosperity brings. May our good wishes go with them, in the hope that they may profit by our experience, and meet prosperity with their standards still high and their faith undimmed.

What, then, is the standing of the Entomologists, as they prepare to take their place in the modern world? A society whose efforts and achievements have been recognized the world around, a society that has not only laid the foundations of insect control for America, but for every corner of the earth. We speak, today, of America as a "world power." The Economic Entomologists of America have been a "world power" for a generation. Our "fourteen principles" have long since been accepted by all nations. Is it possible, you ask, for a society with such a record, to be outstripped by one just out of its swaddling clothes? Let us hope that it is not. Let us do more than hope; let us make sure that the traditions of the past may be continued and enhanced in the work of the future. Let us examine the situation from every angle, weigh each factor, recognize error and shortcoming, if such exist, and lay our foundations for an even more brilliant future, founded on the achievements of a glorious past.

There are three fundamental factors to consider in estimating the productive power and possibility of development of a scientific organi-

zation. They are its foundations—its attitude towards truth—and its vision.

Let us measure ourselves by these standards. As a society we have been felicitated and congratulated, our valuable works enumerated, our contributions heralded, our recommendations adopted, until we have become complacent and self-satisfied. Optimism and self-congratulation are good and will carry one far, but sometimes they lead into by-paths of ease and forgetfulness, to that relaxation of aggressiveness and vigilance that comes with age, while youth, vigor and the critical attitude that comes with introspection and unfulfilled ambition, would have guided away from the danger and held us to the path of progress.

We have also been handicapped in establishing our foundations, by the fact that we are dealing with by far the largest single group of living things. Not only are they countless in number, but infinite in variety and complexity, reaching out in their adaptations into every other form of life, involving in their reactions, almost the entire animate and inanimate world. With a field so vast and varied, so manifestly impossible to cover, it has probably been easier to be contented with the superficial and the immediately important, rather than to search deeper for the foundation stones upon which, alone, an enduring science could have been builded.

Twenty years ago a bomb shell was dropped into our midst, by a president who dared to question the very foundations of our economic science. His exposition of "The Lassier-faire Philosophy" raised a storm of protest and denunciation. Predictions were freely made, that it would cut off our financial support and cripple our development. We are still strongly supported and if anything, too popular! Whether for good or evil, that presidential address is the one that remains vivid and outstanding in the memory of the writer. It has tempered many an exuberance; it has been an antidote to dogmatism and a cure for complacency. In questioning our foundations it caused us to pause and consider them as seriously at that time, as we must do again today.

What, then, is the status of our foundations? Have we completely solved the problem and mastered the intricate relations of a single injurious insect, or have we skimmed the surface of the knowledge of thousands? Have we exhausted the possibilities of discovery of one of the factors of insect development or control? Do we know the relative limits of egg production of our injurious species? Are the number of eggs produced relatively stable or influenced by environmental factors? Do we know the number of annual generations of our insects and the factors that control those numbers? Do we understand the periodicity

of insect appearance and the factors that bring it about? When shall we forecast insect abundance as we now forecast the weather and crop production? Do we understand climatic and ecological factors in insect distribution? Have we lived with these insects as Agassiz lived with the fishes or Audubon with the birds, or have we observed them in the stated hours of an office day? Why has the chinch bug, once seriously injurious in northern Wisconsin, abandoned the state? Why has the box-elder bug moved to the northeast? Why has the corn-root worm moved north-west? Why is the codling-moth extraordinarily abundant in the arid regions, while the potato bug is there unknown? What caused the disappearance of the Rocky Mountain locust? Why does temperature accelerate the development of one insect and retard that of another? Why does a single puncture of one insect cause more injury to a plant than a hundred punctures of another species?

Beneath these and a thousand other problems, are the principles that underlie our science. They involve many factors and interrelations with all the sciences. They have been approached from many angles and through the medium of thousands of different species. Their ramifications extend through an overwhelming mass of literature, not only entomological, but extending into many related sciences. The solution of even a single one of these problems involves long and protracted study, the following out of many related factors, interpretation of many obscurities, the mastery of a voluminous literature and finally the organizing of the completed whole into a form from which a simple deduction can be drawn. Such a problem is worthy of a life's effort—of years of preparation, joined to fruitful years of investigation, finally to be crowned with the satisfaction of a work well done.

It is for us to study our educational system and see if we are offering the proper training for such a task. Are we offering or requiring a major amount of broad and fundamental training in Physics and Chemistry, in Botany and Zoölogy, in Physiology and Geology, in Bacteriology and Genetics, with a minimum of requirements in our special line and those of fundamental character? On such a foundation as that, a lifetime of study and research can be builded, and the structure remain stable and upright.

In many institutions of today, however, the tendency has been to narrowness and specialization, to reduce the number of foundation courses, and increase the number of so-called practical courses, to train in the art, instead of the science. A recent catalogue outlined a course with twelve studies in the major subject and only three in fundamentals. A graduate of that course might be ready to meet almost any superficial question of general entomological knowledge, but he would be woefully lacking in the fundamentals that would prove the enduring

foundation for exhaustive research. Is it not possible that if every special entomological course in this country were abolished and aspirants for entomological honors were required to take a general science course, with broad requirements, that the entomology of the future would be the gainer thereby?

Our mad scramble to turn out nursery inspectors and extension specialists, walking encyclopedias of miscellaneous information, some of which is false and more of which is doubtful, may tend to popularize entomological science, but will never ground it. The extension slogan, "that it will take ten years to carry the researches already made to the people," is the most pernicious doctrine of our generation. Granting that it is true, and it probably is, there still remains the fact that much of that which is now being carried will have to be corrected or contradicted, when the truth is known, and that the whole trend of education and extension is away from that serious and fundamental research, which alone can reveal the truth for which we strive. One of the leading directors of Agricultural Research recently announced that he would prefer to select his men from a university where no agriculture as such, had been taught, than from an agricultural college where too much time had been devoted to the art, and too little to the science; arguing, and no doubt justly, that the research man with the broad foundation could easily acquire the art of a particular agricultural problem, while a narrowly trained man would never acquire the broad scientific foundation, necessary for its solution.

In this connection, it would be well for us to consider that the science of entomology is so tremendously broad and intricate, that it is impossible for any man to longer attempt to master all the details. If we recognize this, we shall hereafter give broader fundamental training in entomology, in order to meet the general requirements and then encourage group specialization. In such a limited field, one may still hope to obtain a mastery. Under past methods, a single experiment station worker has undertaken problems involving practically all orders of insects, with the result that it has been impossible for him to master the literature of any one. Many times his so-called researches have only carried the investigation of problems to the same position that had been reached by previous workers, there to be dropped and another taken up. On the other hand, some of the most fruitful workers in the past have been able to confine themselves to one or at the most, two or three fields, have mastered the literature and the methods of procedure, in their restricted groups, and have contributed greatly to the sum total of human knowledge.

In the olden days, we had the savant that knew all things, the philosopher that reasoned all things, and even later, the scientist that

dabbled in all science; today we have entomologists, tomorrow we will have group specialists, who will not be afraid to say that there are many other fields in entomology, to them unknown.

A stream can rise no higher than its source. The future of entomological science depends upon its foundations and those foundations depend upon the work of the present generation and the inspiration transmitted to those to come.

The Attitude Towards Truth

The attitude of the society towards truth should always be receptive—more than receptive, eager. We should, as an organization and as individuals, welcome constructive criticism. We should go even further than this, and provide the machinery of analysis and organization that would encourage and even solicit criticism. The link which binds the members of this society together is that we are all searching after truth. There can be no legitimate place in such an organization for the perpetuation of error.

There has, however, grown up in this society, a tradition that anyone who disturbed the peace and harmony of this continuous output of error was a knocker and a trouble-maker. To such an extent has the propaganda been carried, that the only form of criticism that is now tolerated, is that of syntax and etymology, while entomology suffers from the constant repetition of misinformation and ancient error.

We need criticism—constructive criticism if possible, but criticism—honest criticism, in any form, should be welcomed and encouraged. Many mistakes of observation or errors of deduction, known by many workers to be such, are still current in our literature, and are being reiterated and republished to this day, due to the attitude of this organization, towards the individual who would criticise.

The demand for entomological information has been so great, and the general informational bulletin so much in vogue, that many of us have grown lax in the matter of giving proper credit for material used. Even in scientific papers or technical journals, the material is appropriated and used without credit. Much of this material is antiquated and too much of it erroneous. Anyone using such material cannot plead previous publication by any one else, as justification. He becomes responsible for the error and should be held accountable.

When entomology was a struggling science, when economic problems were many and the workers few, there may have been justification for this laxity. There can be none now. Because Riley figured grasshoppers laying eggs in an impossible position, fifty years ago, is no justification for anyone claiming to have investigated the grass-

hopper, to perpetuate that error, and yet it has only been within a few years that it was publicly corrected. In that same publication, other errors of observation were recorded, and are still being perpetuated and republished without credit, to this day. When a question of their correctness is raised, they refer you back to Riley. Riley did a wonderful work, which we all recognize and revere. He also made many errors, which he, himself, would have corrected, if he had had an opportunity to repeat the work. Loyalty to his great name, to truth and to the science of entomology, which we are all striving to establish, all demand that these errors be eliminated. Let Riley be credited with what he did, his errors corrected, and let later workers be credited with their contributions.

This society should have a permanent committee on publications, who should formulate rules and regulations, the same as we have rules for systematic work, to which economic publications should conform. These rules should provide for three classes of economic publications:

First: Popular matter, claiming no originality and therefore no credit. In such publications it should not be necessary to give credit, although in many cases, reference to the source will strengthen the appeal.

Second: Publications purporting to contain original matter. In such publications it should be required that the status of knowledge be set forth in a preliminary review, in which due credit is given to each contributor, and this followed by the contribution of the writer, or else, that the whole subject be discussed with due credit to previous work, and that there be a summary in which the original contribution of the writer is specifically claimed and set forth.

Third: Summaries and reviews, in which every worker be specifically credited with his contribution.

A strong and carefully thought-out set of regulations, along these lines, to be enforced by the society, and administered by a strong and responsible committee, would have a powerful influence in strengthening, condensing, and unifying our economic literature. If all economic publications would adopt them, and the attention of experiment stations and other sources of publication be called to their provisions, it would be of inestimable value in clarifying our knowledge.

The tremendous accumulation of economic literature, much of it admittedly popular, but in most of which no differentiation is made between contribution and compilation is one of the serious and growing handicaps to progress. This society should spend much less time in listening to detailed reports of minor experiments and more time in discussing ways and means of solving the problems of the future. Catalogues, bibliographies, indices and summaries, are imperative, if

this enormous mass is to be assimilated and profitably used. More funds of this association should be used for this purpose and more influence brought to bear, on sources of publication, so that offerings of this kind could find ready acceptance. The bibliography of Economic Entomology should be kept up to date, and arrangements made to bring the valuable contributions into a single bibliography.

The committee on publications might well be charged with the problem of reviewing past literature and fixing credit for at least major discoveries in our science. By a system of sub-committees and the use of specialists who already have a large part of this information, the task could be accomplished and every worker immeasurably benefited by the knowledge. The committee might well adopt the policy of requesting each living worker to set forth his own contributions to knowledge, asking him to go farther and classify them into major and minor groups. Overlapping claims and inaccuracies could be worked out, and the whole unified and correlated, in such a way as to make it highly valuable to every worker. It would require a certain amount of time and effort on the part of each individual, but there is, possibly, no more valuable piece of work that the ordinary individual could undertake, than to calmly sit down and measure the value of his own productions in a critical and impartial manner.

We need, also, to be more generous in our credit to assistants and helpers. Credit of this kind, joint authorship, or specific acknowledgment does not, in the least, detract from the credit of the individual, but rather enhances it. The days of feudalism, of the master and slave, are gone. It is pleasant to note that the customs of the Dark Ages are rapidly disappearing, and that the contributions of the third generation of our scientists are practically free from criticism in this respect.

There are many of the fundamental questions of the future that involve the effect of insect attack upon the host plant, whether it is the effect of egg deposition or of feeding puncture or both, whether it is mere mechanical injury or something injected, or whether the insect is a carrier of a definite disease. One plant disease is already known to be transmitted only by the puncture of a specific insect, others appear to be specifically transmitted, while others are transmitted by a number of insects or by other methods. Here is a tremendously important and interesting field, as yet almost unworked.

All of these problems require the coöperation of the Plant Pathologist and Physiologist, and for these and many other reasons, our relations with these societies should be the most cordial and mutually helpful. Many of the problems of the State Entomologist involve pathological and physiological factors, and in all of this work, the coöperation and assistance of these plant workers should be sought.

It is only when the closest coöperation and sympathy exists, that the greatest good can be accomplished. A joint meeting of the two societies each year, for the presidential addresses, would be a powerful factor in bringing about mutual sympathy and understanding.

Vision

Of all the fundamentals, the power to see the possibilities and opportunities of the future, is probably the greatest and possibly the rarest. Happily, however, a single leader may lead an army. A Moses, from his cradle in the bulrushes, led a nation to emancipation; a Columbus sailed on and on, towards a shore no eye had ever seen; a Foch could see through the smoke of battle, to the fields of battles and victories, yet to come. These, and a thousand others, have led because they could see beyond the present and accomplished, because they dared the unknown. Their vision and their faith were the creative powers that established the modern world.

It is America's boast, that yellow fever does not exist under the Stars and Stripes; that the Bubonic plague, the triple alliance of the rat, the flea and the bacillus, has been practically routed from civilization; that scabies, the scourge of the western range, has practically disappeared as a menace to the sheep industry; that the foot and mouth disease has been banished from our soil. Newell calls attention to the fact that the quarantine line of the Texas fever has steadily been pushed southward, until it has touched the Gulf, and will eventually disappear. These and other striking victories of scientific warfare have involved problems partially entomological, but have been accomplished largely through other agencies. Newell has already called attention to the eradication of the citrus canker, with its almost phenomenal success. The campaign against the barberry has met with a wonderful and almost unbelievable response. The spirit of conquest is in the air, and if the Entomologists are to carry their standard in the fore-front of this modern warfare against the enemies of old, they must search the rushes for a Moses.

Notable achievements are already to their credit. The cottony cushion scale has been subjugated, the gypsy and brown-tail moth compelled to intrench. The waves of molesting mosquitoes have been driven back and their bivouacs destroyed. The advanced spies of devouring hordes have been stopped at our shores. The pink bollworm is now in retreat. These and other achievements have been notable and worthy, but should be followed by even greater ones. The cottony cushion scale should not only be subjugated, but exterminated. The warble fly passes the greater part of its life in an exposed situation on the backs of the cattle. A concerted effort and a

thorough organization, with the power and push of American energy and ingenuity, would eliminate this pest in a single season. It would hardly be accomplished, before the gain in leather and increased production would have paid the cost. The codling-moth is restricted to the apple and one or two allied fruits and nuts for its existence. An organized force, taking advantage of short crops, by reason of frost or previous heavy bearing, could free an entire region in a single year. By rigid quarantine it could be held free, until adjacent regions received like treatment. Area after area could in this way be cleaned up, until this scourge was driven from our shores. The state of Texas offered \$50,000 reward for a plan of control of the cotton-boll weevil. Three hundred claimed the prize, but none succeeded. This pest is entirely dependent upon the cotton plant for its existence, and as Newell has pointed out, if the nation would store cotton in advance and cease to grow the crop for a single year, its eradication might be accomplished. It would be even possible to divide the country into three districts, increase the crop production in one area, while it was eliminated for two seasons, in the others. In this way, it could be more certainly eliminated and still cotton produced.

There are many who will say that all of these things are impossible and we will grant that they are, but you will remember that it was impossible to build the Panama Canal, but a Goethals builded it. It was impossible to put a million men in France. Statistics showed that there were not trains enough to move them, nor ships enough to carry them. It was altruistic, but impossible. It was also proved to be impossible to feed them, even if they could have been placed there. There was overwhelming evidence to these conclusions, and yet these men and many more were placed on French soil and the food was there in abundance. The trouble with the statisticians was that they forgot the power of leadership and organization supported by the enthusiasm and self-sacrifice of a free people.

There are doubtless scores of other insect pests of prime importance, that have even more vulnerable spots somewhere in the armor of their development. It is only a question of finding it and organizing for the attack. The Economic Entomologists are weak in aggressive organization, to meet the conditions of today. They should have a strong and permanent executive committee, presided over by the strongest leader of our band. To this committee should be intrusted the organization of our efforts to the accomplishment of these ends. This committee should decide on the problems to be attacked, the method of operation, and the organization of public support and coöperation so essential to success. The society should change its rules, so that the president would serve for the year following his address and the ap-

pointment of his committees and thus actively assist in carrying out the policies that he proposed.

The Economic Entomologists will become more active and aggressive, if they fulfill their destiny and keep abreast of the progress of the modern world. They will broaden and strengthen their courses of instruction, insist on fundamentals and foundations in all branches. They will require longer and more adequate preparation for research and thus establish standards beyond reproach. They will welcome criticism, be generous in credit, seek coöperation; they will ally themselves with all forces that fight for the freedom of the earth from pest and disease. They will have faith to attempt the impossible and finally triumph, as do all forces that battle for truth and right.

At the close of the address a vote of thanks was extended by the association, after which the session adjourned.

Afternoon Session, Thursday, December 26, 1918, 2.40 p. m.

President E. D. Ball: We will now take up the first paper on the program, by T. J. Headlee, New Brunswick, N. J.

PRACTICAL APPLICATION OF THE METHODS RECENTLY DISCOVERED FOR THE CONTROL OF THE SPRINKLING SEWAGE FILTER FLY

(*Psychoda alternata*)

By Thomas J. Headlee, Ph. D., *Entomologist of the New Jersey Agricultural Experiment Stations and State Entomologist*

Introduction

Except where trade wastes are discharged in sufficient quantities materially to affect the effluent, sewage purification is essentially a process of transforming chemically unstable compounds into those which are chemically stable, and a process of reducing the number of pathogenic organisms to the lowest possible point, to the end that the water which has been used as a carrier for the sewage matters may be discharged into streams without polluting them in such a way as to be a menace to human health. The transformation of the chemically unstable sewage compounds to the chemically stable is apparently a bio-chemical process. The society of animals and plants effecting this change apparently reaches its highest development in the sprinkling sewage filter. The broken stones of which the body of this type of filter is composed are more or less completely coated with a gelatinous and amorphous film in which live the millions of organisms which effect this transformation. The organisms concerned are representatives at least of Bacteria, Fungi, Protozoa, Nematoda, Rotatoria,

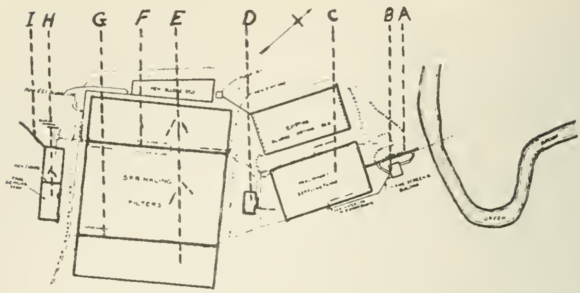


Fig. 1.—Diagram of the sewage purification plant where work against sprinkling sewage Filter Fly was carried out. Raw sewage enters at A, passes through B, C, D, E and H, and the purified effluent escapes through I. The flies are produced in E.

A—Stream of raw sewage; B—Screen for removing coarse matter; C—Preliminary settling tanks; D—Siphon dosing tanks; E—Sprinkling filters; F and G—Galleries leading the sewage into and out of the sprinkling filters; H—Final settling tanks; I—Stream of effluent.

Chætopoda, Crustacea, Arachidna, and Insecta. The exact part which each group of organisms plays in the process of sewage purification is still an unsolved problem. The *Psychoda* are, however, concerned in the reducing of the gelatinous and amorphous film, living in it and consuming it. The principal species of *Psychoda* found doing this work at the Plainfield sprinkling sewage filter is *Psychoda alternata*.

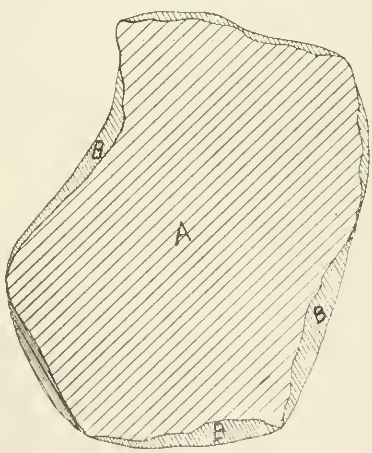
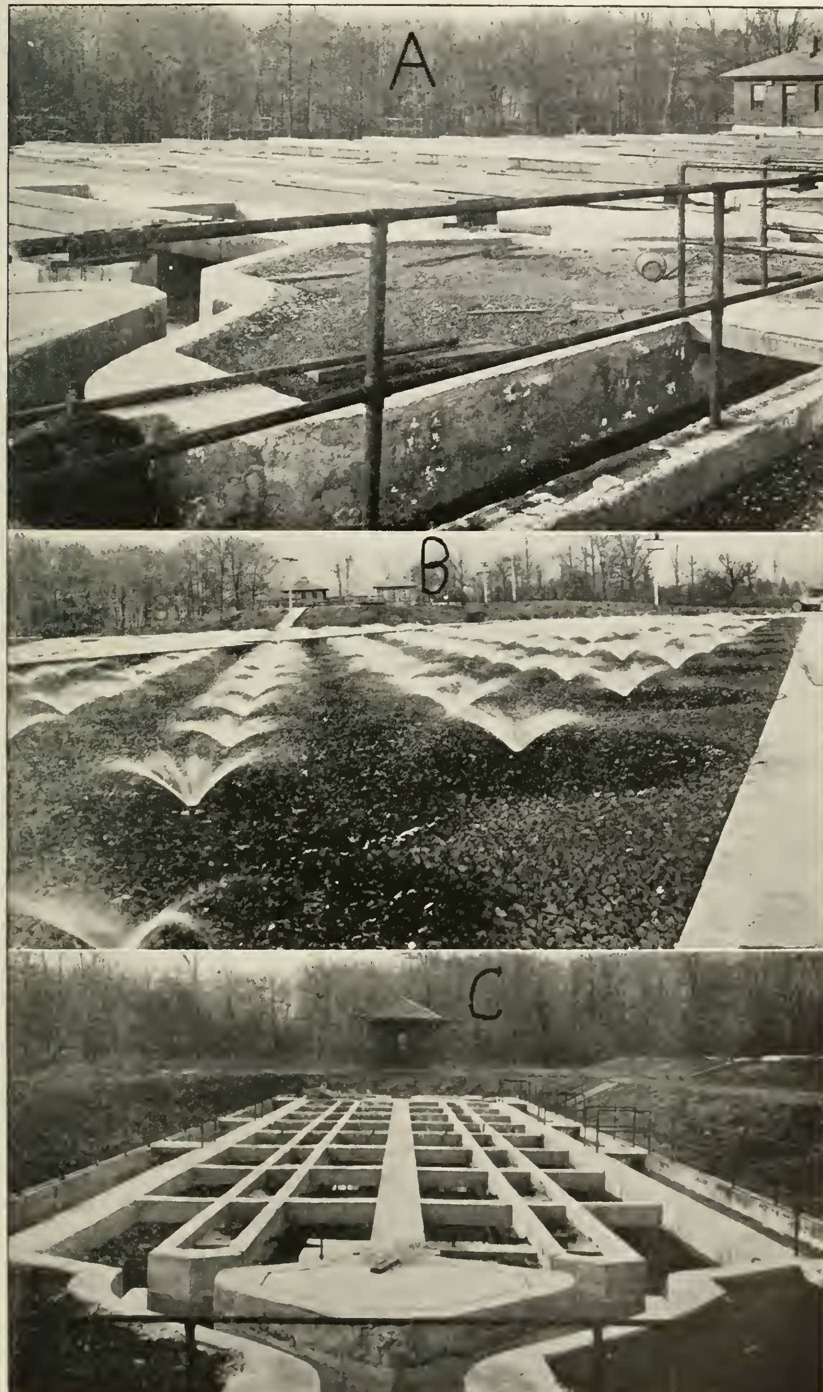


Fig. 2.—Diagram showing relation of film to stone. A, Stone; B, Film.

Nature and Extent of Injury

So far as the present studies have gone there is nothing whatever to show that the Sprinkling Sewage Filter Fly in any way damages or interferes with the efficiency of the society to which it belongs. The adult flies, however, emerging in enormous numbers throughout the fore-part and throughout the latter part of the warm season, fly or are wind-carried for a distance of at least three-fourths of a mile, penetrate the finest screens and fall into the food which is presently to be consumed by people. Knowing the source of these flies and seeing them in the food, is sufficient to convince the people concerned that almost any infection from which they may subsequently suffer has been brought to them by this agency and to cause them to file suits for damage against the concern or the municipality maintaining the sewage

Plate 1. General view of the preliminary settling tanks (A), the sprinkling filter (B) and the final settling tanks (C). Sewage passes through in the order named. The flies breed in the sprinkling filter.


A
B
C

purification plant from which they come. Whether these flies actually carry infection has never been determined, but the presumption that they do is not at all unreasonable.

Almost wherever sprinkling sewage filters are maintained these flies are produced and trouble of this kind is likely to occur.

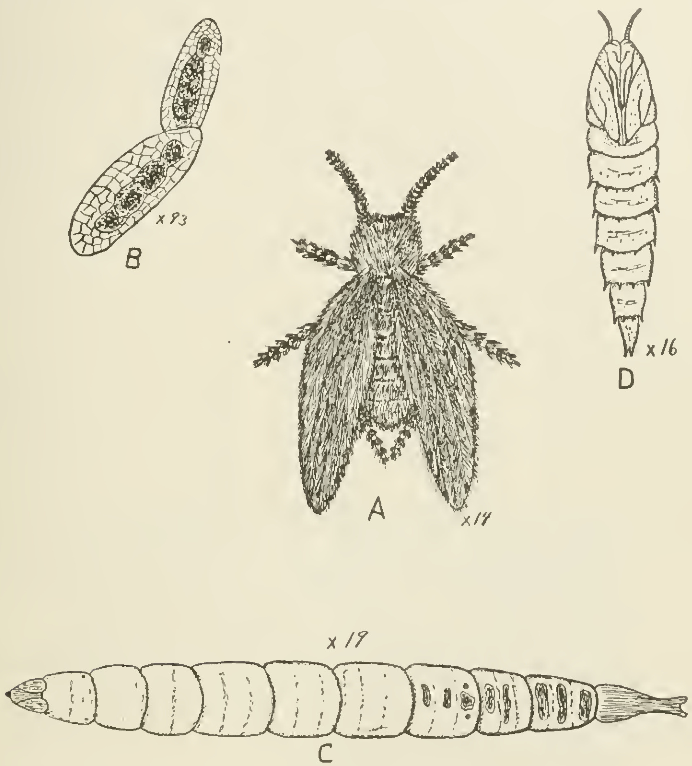


Fig. 3.—Life stages of the Sprinkling Sewage Filter Fly. A, Adult; B, Eggs (After L. Haseman); C, Larva; D, Pupa.

Life-History and Habits

The Sprinkling Sewage Filter Fly remains in the filter throughout the entire year, but to what extent breeding takes place in the winter time we are unable to say. Reproduction, however, occurred during the month of December, 1918.

The eggs are laid on the film. The young hatch and make their way into it. Here they establish themselves with the breathing tube projecting from the film surface and the body buried in it. In this position they feed and grow to maturity. Transformation to pupæ takes place in the film and the pupæ assume a position with their two breathing tubes sticking through the surface and the rest of their

bodies buried in the film. When pupation has been completed the front end of the pupal shell is burst open and the fly emerges.

The insect is not a strong flier and its movements from the filter are much influenced by the wind. It has the habit of resting on the undersides of the stones in the upper layers of the filter and upon the sidewalls of the filter itself. The life cycle may be completed in the summer in a minimum of a little less than 12 days. As a matter of fact, a brood emerges during the summer about once each two weeks.

Although larvæ and pupæ of this fly may be found throughout the filter bed, they are most abundant in the zone which begins three inches below the surface and ends about twelve inches below the surface.

The abundance of larvæ and pupæ seems to be correlated with the thickness of the film. A thick film means heavy breeding, a thin film light breeding. During the winter and spring the film becomes very heavy and consequently the pest is very abundant, in the fore-part of the season. As the weather becomes warmer the filter unloads. Large quantities of the film sluff off and pass out with the effluent, and a thin film takes its place. This thin film gradually increases in thickness as the summer goes by, until in the latter part of the summer it becomes heavy and consequently develops a great abundance of flies.

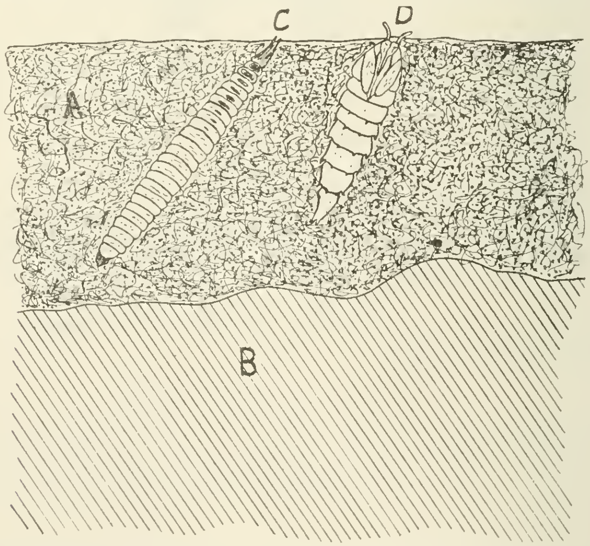


Fig. 4.—Diagram showing position of larva and pupa of the Sprinkling Sewage Filter Fly in the film. A, Film; B, Stone; C, Larva; D, Pupa.

Control

Practically all of the organisms composing the society of which the Sprinkling Sewage Filter Fly is a part, can get along without atmospheric oxygen for a longer time than it. Both the larvæ and pupæ

breathe atmospheric air. Tests made and reported[1] show that submersion of the filter bed with ordinary sewage for a period of 24 hours destroys 100 per cent of the larvæ and pupæ, leaving the film in active condition.

The first experimental submergence was made on June 14, 1918, and involved only one-fourth of the entire bed which has a surface of about two acres.

Acting upon this discovery, a bulk head pierced with a passage way which may be closed or opened at will was installed in each of the two galleries through which the effluent escaped from the filter bed of the joint sewage disposal plant of Plainfield, North Plainfield and Dunellen; a plant which serves to purify the sewage of about 40,000 people.

The factors affecting the submergence of the entire bed were tightness of the retaining walls, the volume of sewage available and the time which the bed could be submerged without injury. The retaining walls in question were composed of six-inch concrete backed by a heavy wall of soil lying at an easy angle of rest from the top of the retaining wall to the surface of the surrounding ground. This concrete wall had not been constructed to hold water, but merely to hold the stone in place and it surrounded a basin of approximately six feet deep. The normal volume of sewage ranged from $2\frac{1}{2}$ to 4 million gallons daily. The time during which the filter could be submerged and not seriously injure the activity of the film as shown by the following table was something less than 48 hours.

Flooding Experiment Carried out in Flower Pots

Length of Time Flooded	Condition of Larvæ	Condition of Film
16 hours	Alive	Alive
18 "	"	"
22 "	95 % dead	"
24 "	Dead	"
32 "	"	"
36 "	"	Slight putrefication
48 "	"	Putrefaction

The figures indicated that the filter should be filled with sewage, provided the walls did not leak seriously, within a period of 12 hours.

On August 9 the bulk head gates were shut and the water allowed to accumulate. The filter was completely under water at the end of 12 hours and was maintained in this condition for a period of 24 hours, when the bulk head gates were withdrawn and the waters allowed to escape. These escaping streams of water were full of the dead larvæ of the Sprinkling Sewage Filter Fly.

[1] Headlee, T. J., Beckwith, C. S. Sprinkling Sewage Filter Fly, Journal of Economic Entomology, Vol. II, No. 5, 1918.

Assuming that the nitration power of the bed is a proper index for its efficiency in sewage purification (this is the index usually so accepted by Sanitary Engineers), the following table will serve to show that the efficiency of the bed was in no wise diminished by the submergences of the season.

Effect on Nitrification in Plainfield Filters

Part Per Mill N. as Nitrate

Number of Days before Flooding							Dates	Number of Days after Flooding						
7	6	5	4	3	2	1	Flood	1	2	3	4	5	6	7
			7.0	10.0		12	6/14	11.4	Eff. of quarter flooded only					
						. 11	8/9	11.	10.	8.0				
			13.0	9.0		13	8/24	13.0						
		13.0					8/31				13.0			
			13.0			13	9/17						13.0	
						13	9/24	13.0	13.0				13.0	
6.1							10/14	10.0	11.0				10.0	
				6.6	6.6	6.6	10/31				6.6	6.6		6.6

This submergence was repeated on August 24, August 31, September 17, September 24, October 14 and October 31.

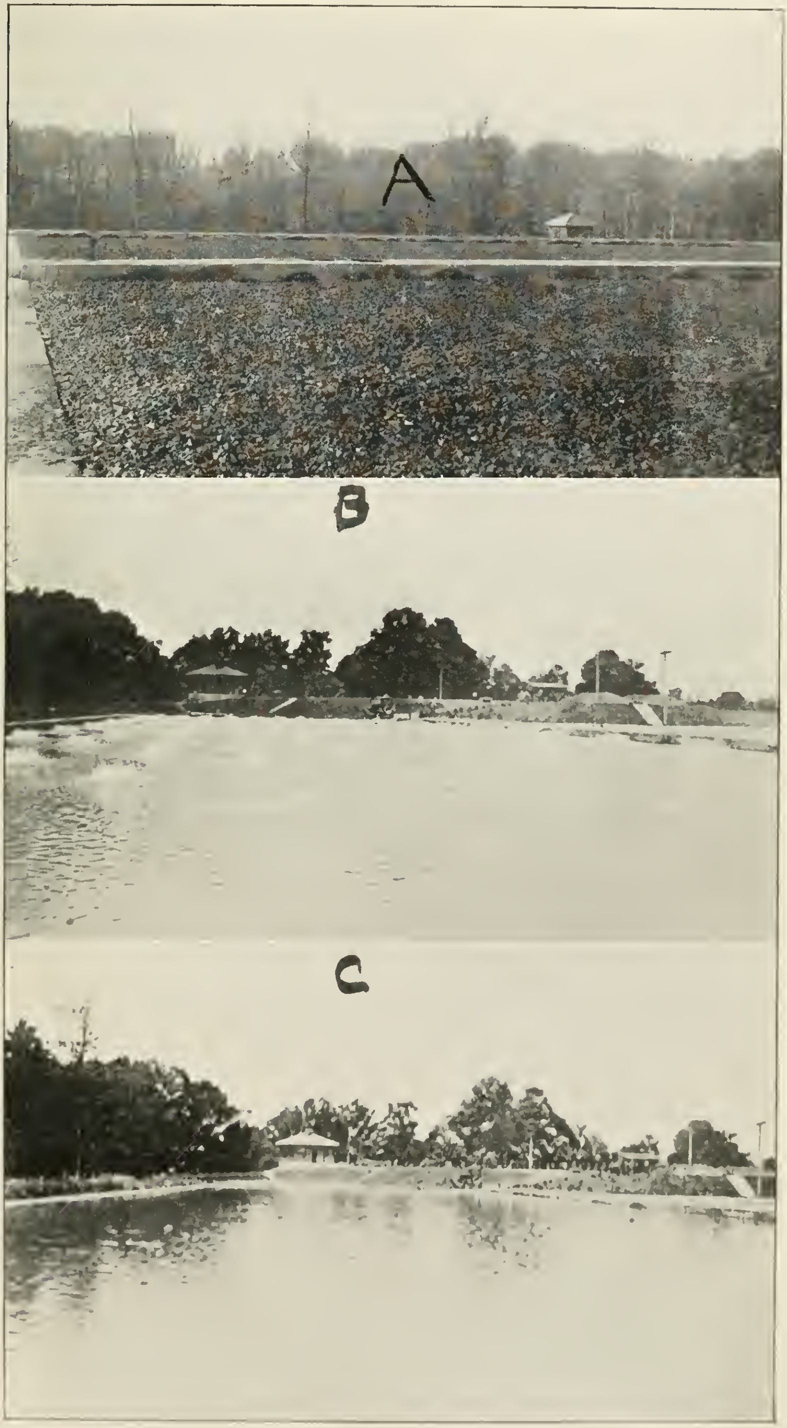
With the exception of the periods from August 24 to August 31 and September 17 to September 24, the time elapsing was two weeks or greater. The result of the practice of allowing two weeks to elapse before the submergence is repeated appears in the escape of a considerable number of flies. A repetition of the treatment at the end of one week cuts the fly pest entirely out. The two-week period gives enough time for the flies to reach the adult stage and to reinfest the filter immediately after the water is withdrawn. Furthermore, it is possible although not actually determined that the egg is able to resist the submergence.

It is unmistakeably indicated that the filter should be submerged once each 10 days until the flies are reduced. Let it be understood, however, that at no time following August 24 did the fly assume the proportion of a pest, although the interval between submergence with two exceptions was sufficient for the insect to pass through its life cycle.

The work against the fly will be opened during the coming season by submergence of the bed in the spring before the flies emerge. This submergence will be followed by treatments at 10-day intervals until the fly has been so reduced as not to require such frequency.

The greatest limiting factor in the application of this method of controling the Sprinkling Sewage Filter Fy to the various sprinkling sewage filter beds of the country is the fact that many engineers have constructed these beds without retaining walls. In such cases the writer would recommend the construction of wooden walls backed by an earthen fill or the construction of concrete retaining walls, in such a

Plate 2. General views of sprinkling filter illustrating submergence. A.—Filter inactive, note apparatus for closing and opening the bulkhead gate; B—filter approaching complete submergence, sprayers discharging; C—Filter completely submerged.


A
B
C

fashion as to permit the filling of the bed in 12 hours and the maintenance of the submergence for a period of 24 hours.

The writer wishes to take this opportunity to acknowledge his indebtedness to Dr. Leonard Haseman for identification of species, to the Joint Sewer Committee of Plainfield, Dunellen and North Plainfield for substantial aid in carrying out the experiments, to Mr. John R. Downes, superintendent of the disposal plant, for hearty coöperation in the practical work of submergence and for furnishing data on nitration, and to Mr. J. W. Thompson for making the drawings.

President E. D. Ball: This paper is before you for discussion.

Mr. W. A. Riley: I had the pleasure of seeing some of this work last spring and was very much interested in the fact that while it had not been established definitely that those flies were carriers of disease, we have every reason to suppose that they would be under such circumstances, and I sympathize heartily with the people who brought suit against the corporation for maintaining such a nuisance. I think that Dr. Headlee's work will be very far reaching in its applicability. For one thing, a little later I saw the filter beds and the system in use here in Baltimore, or near this city. The beds of course are enormously more extensive and the pest was just as serious here. There have been a number of suits brought against the city and decided adversely to the city here, and this certainly should be a matter of much interest to the authorities in charge of that work.

Another factor which impressed me especially in the beds here was the number of other species of flies, including the house-fly, and a number of the larger Muscids breeding in these beds. I did not see that to any such extent at the beds in New Jersey, and that was very apparent when I visited the sewer beds here. The problem for this particular locality would make a very valuable and interesting one for some one who has local opportunities to take it up.

President E. D. Ball: Is there any further discussion? If not, we will call for the next paper.

THE OCCURRENCE OF DROSOPHILA LARVÆ AND PUPARIA IN BOTTLED MILK

By W. A. Riley, *St. Paul, Minn.*

(Withdrawn for publication elsewhere)

President E. D. Ball: The next paper on the program is, "Some Practical Phases of the Entomology of Disease, Hygiene, and Sanitation Developed by the War," by W. Dwight Pierce, Washington, D. C.

SOME NEW PHASES OF THE ENTOMOLOGY OF DISEASE, HYGIENE AND SANITATION BROUGHT ABOUT BY THE GREAT WAR

By W. Dwight Pierce

Since the great war began in Europe a branch of entomology long neglected has suddenly grown from infancy to maturity. Five years ago we had a few text books of medical entomology, and two or three universities presented courses of study in the subject. But medical or sanitary entomologists were so little known or thought of, that no place was made in any of the armies for men trained in the subject. Little by little, however, in the various armies there has been an infiltration of entomologists and it is my firm belief that the day will come when every army will have an entomological unit in its sanitary corps.

When our nation entered the war the men who were well informed on the subject of this phase of the entomological science could not have exceeded a score. But all entomologists were thinking of their part in the great struggle, and when it was announced in a three-line statement in an emergency circular that a class had been formed to study the entomology of disease, hygiene and sanitation, and that mimeographed proceedings would be sent to those who enrolled, the nation-wide interest of the entomological profession was immediately demonstrated.

The class kept on growing steadily until its enrollment exceeded 500, and many universities and colleges announced the founding of special classes in the subject. But it is not only the educational side of the subject which has grown. Hardly a day passes but that some new contribution to the science comes to hand. The technical phases of the problem are fast maturing.

Just arrived at maturity, we cannot yet prophesy the future of this branch of entomology, but it is well to see what kind of a ground work it has and what some of its new, outstanding features are. This paper is intended to serve as a setting forth of some of the basic principles of this phase of entomology.

Our science embraces the study of all the relationships of insects to the causation and carriage of disease, whether of plant or animal, because the principles are the same, and the technique is similar; the rôle of insects in materia medica; and the maintenance of hygienic and sanitary conditions for man, animals and plants, against all insects which threaten the health of these individual organisms. We touch in the various angles of the complete science many other sciences and must maintain our own entity without arousing antagonism of other sciences, but rather with a perfect accord and coöperation with them in

order that we may more quickly solve the many problems ahead of us.

In the study of disease transmission we must work directly with doctors, and parasitologists in perfect harmony. It is our rôle to understand the life-histories of the insects, their hosts and their parasites, in order that we may point out the possible manners of transmission, to assist in the transmission experiments, and to maintain the surroundings of the experimental insects such that the experiments can be successfully concluded. The doctor and the parasitologist will be just as concerned with the patient and the organism as we are with the carrier. Had such coöperation been in effect in the past, it would not be now necessary to reconduct many transmission experiments which proved failures because of faulty technique in handling the insects, or efforts to obtain transmission by bite when it should have been accomplished by some other method.

Briefly, we must summarize the methods of disease transmission by insects. The organism may be carried mechanically on the body or in the mouth parts, or may pass through the body of the insect and out with its feces. The host may be infected by the insect coming in contact with food or wounds, or by mechanical inoculation at the time of a bite, or by the insect being scratched into a wound, or by having its feces scratched in. Its feces may be dropped on food or be washed into the blood by fluids excreted by the insect at the time of feeding. The organism may require the insect as an intermediate host, and may follow many devious paths in the insect body, emerging from the region of the mouth or anus, or may never be contaminative in this manner, but require to be swallowed in its insect host by the next host in its cycle. Insects little suspected of having any rôle in disease transmission are often vital elements in the economy of a disease organism.

Since the beginning of the war the body-louse has assumed a primary importance as a carrier of some of the most dreaded diseases. Valuable studies have been made in India on the rôle of the bedbug as an intermediate host of Kala azar and kindred diseases. Further advances have been made in the study of sleeping sickness in Africa.

An outstanding feature of the louse and bedbug studies is the fact that these insects do not spread diseases by biting, but by being scratched into the flesh or having their feces scratched in. The importance of these studies must not be minimized, for quite possibly we have here a probable explanation of the means of ingress for a number of other diseases which have baffled investigators.

The part of insects in materia medica is but little known and is a field for future investigations. Certain it is, however, that insect

secretions are often very powerful and that some of those known are of very definite value.

Probably the greatest series of advances in this science have been made in the louse investigation and as a direct result of the proving that the most dreaded diseases of the armies, typhus, relapsing fever and trench fever, were louse transmitted. We will not discuss the louse problem as such but rather bring out some of the new principles which it has given entomology. Nuttall's great series of monographs on the human lice, recently published in *Parasitology*, cover the general subject very well.

There are a number of army principles more or less understood and perhaps not even set forth on paper which have actuated much of the work done on this subject. In this war everything has been handled on a scale far surpassing anything ever dreamt of before. We have had to think in millions and not in units. We have had to test each proposed method of insect control in terms of universal availability, and maximum effectiveness. Because of the immensity of the problems, scientists of many branches have contributed wonderful results to our new entomological science. We owe immeasurable credit to doctors, sanitarians, chemists, engineers, manufacturers and to the ordinary man of the street. All the brains of the nations of the world have been focused on winning the war, and one of the vital elements therein was the health of the great armies facing each other. There have been many valuable contributions from various sources on the control of the louse.

It is an army maxim that materials and methods already in use in some part of the army, and therefore more or less available, must be adapted to meet as many phases of army life as possible. New problems must be handled if possible with materials at hand. The army sanitarian must learn to shift for himself and get results without introducing too much that is new. He must be able to get results by rough and ready methods. A given unit of machinery or transportation must have its various capabilities for use tested to the utmost. The more uses a chemical has the better. Materials usually wasted in former wars are now carefully studied with the possibility of utilizing them. Waste must be reduced to a minimum. Methods, materials, mechanisms must be standardized and must be readily available. Theoretical knowledge is of little value, results count. Everything must submit to the cold proof of results. Inventive genius which can transmute ideas into practical working propositions stands high at present.

Now let us see how these principles have governed the cootie investigation and also some of our other entomological sanitary problems. We should put them to use in all our future entomological work.

The louse is an insect of filth. It is to be controlled by cleanliness, by heat, by water, by chemicals. Thus we have seen the rise of the bath trains, the mobile horse-drawn and motor-drawn bath units, the permanent bathing stations; we have seen efforts made to bathe whole nations and their armies in order to combat louse-borne diseases. To the Russians probably belong the credit for the first mobile bath units. Now they exist in many diverse types. The basic principles in the bath unit are that the men shall be bathed and their clothes sterilized and that there shall be no contact between clean and unclean garments or clean and unclean men.

The greatest problem in sterilization of the clothes is to kill all lice and vermin and all disease germs without injury to the garments, and when to sterilization can be added cleansing then we have the best process of all. The sterilization may be by dry heat, steam, hot water, gas or chemical wash according to the available supplies. Every one of the elements of sterilization has been studied more thoroughly than ever before. Steam sterilization may be accomplished in an autoclave, a room, a car, a kettle, a barrel, or a laundry washing machine; by the use of vacuum, or at normal, or increased pressure in a closed cylinder, or it may be applied as live or current steam. There is no question about the killing value of steam. In the autoclave or sterilization cylinder the complete process requires half an hour, but we have found recently that in a laundry washing machine we can kill all cooties and nits with current steam in fifteen minutes, remove the garments, shake them out and wear them. The problem in steam sterilization is one of shrinkage, and injury to the tensile strength of the fabric. Steam under pressure, even for a few minutes, is injurious to woolens. So also, is steam at ordinary pressure in a little longer time. Current steam does not shrink in fifteen minutes in the laundry wheel. Current steam disinfection of whole buildings and cars has been used and enabled the rapid handling of great quantities of garments. Detailed reports of wool shrinkage tests of many processes have been made as a result of the louse problem.

But steam, in whatever form, although effective, does not cleanse the garments.

Washing with boiling water and washing with insecticidal soaps have been often proposed and successfully used, but it remained for the Laundry Division of the Conservation and Reclamation Branch, Q. M. C., to set in action a series of investigations to determine to what extent the camp laundries could effectively control the louse. It has been the writer's good fortune to be one of the group which investigated all the laundry and dry-cleaning processes with the view of ob-

taining complete insect disinfection. We have reported[1] that the laundry processes are thoroughly efficient delousing processes and that each step in the laundry formula, washing, drying, and ironing, can of itself be so regulated as to completely kill all lice. Furthermore, if very resistant spore-bearing bacilli are suspected of being in the clothes, a live steam sterilization may precede the wash with absolutely no injury to the garments.

This primarily entomological question led to exhaustive studies of the shrinkage of woolens and the bactericidal value of each process in the laundry, and even to actual changes in laundry practice. In like manner, the dry-cleaning processes were studied and developed from each point of view. It was interesting to find that the usual 45-minute gasoline soaking in the wash wheel, and even an hour's soaking, was not effective against all eggs, but the second step in the process, the drying in the dry tumbler, completed the control.

Many people have suggested that chemicals placed on clothing would be effective repellents against the louse, and in fact there is considerable on the subject in European literature, but it was not based on scientific principles of research. This fact led to the exhaustive studies of Dr. William Moore and Dr. A. B. Hirschfelder on impregnation of garments. Then the Chemical Service started to impregnate garments against gases and finally the two efforts were welded into one. Whether we find what we are after or not, this work has already greatly enriched entomology and chemistry with a knowledge of the effectiveness of many chemicals as insecticides, the duration of their effectiveness, and their effects on clothing and skin.

The subject of insect repellents has been studied more thoroughly and scientifically than ever before. Many of the repellents and impregnation chemicals used in these tests were synthesized by Dr. Hirschfelder, and members of the Chemical Warfare Service.

The louse problem is not the only one which has yielded new phases to entomological practice. In the mosquito extermination work Lieut. E. C. Ebert of the Marine Corps, at Quantico, developed a submersible oil distributor, and also worked out many ways of spreading oil by means of oil impregnated sawdust. In the June number of the Journal of Economic Entomology, Freeborn and Atsatt contributed a very valuable paper on the effects of the petroleum oils on mosquito larvæ, which taken together with Dr. Moore's papers on the toxicity of vapors to insects will greatly advance our knowledge of insect control.

The fly problem in the camps led to many ingenious sanitary measures for handling garbage, manure and sewage to prevent fly breeding.

[1] National Laundry Journal, vol. 81, pp. 4–14, Jan. 1, 1919.

Dr. W. L. Mann, Post Surgeon at Quantico, has contributed numerous types of incinerators for all kinds of refuse. The disposal of waste has become more or less standardized by army practice.

An interesting feature in educational work was Dr. Mann's practical field demonstration at Quantico of models of many types of sanitary devices such as latrines, incinerators, sterilizers, steam disinfectors, etc. Certain of the army camps have installed similar exhibits. It is to be hoped that as we get settled down to recognizing sanitary entomology, there will be developed throughout the country many permanent outdoor and indoor exhibitions of sanitary and entomological devices. It is a very effective educational method.

We now come to a brief discussion of the future of this branch of entomology. In the past many times as much money has been spent for the control of insects which damage crops, as for the control of insects which affect the health of man and animals, and yet such estimates as are available show the losses to be more or less equal.

There is therefore a great field for research and practical work to be opened up and now is surely the time to begin. Well-regulated courses of study should be started in all universities where entomology is taught, and surely no medical school should be without a complete course in the entomology of disease, hygiene and sanitation.

Each year we learn of some well-known disease being connected more or less intimately with insects. We must therefore settle down to a careful and systematic study of how insects can be concerned in the transmission of the diseases prevalent among us. This work will involve careful biological studies of all suspected species to equip us thoroughly with a knowledge of their habits and methods of control. Fortunately there is a great mass of material already accumulated, which must, however, be digested.

Many of these biological and practical studies must be worked out from the standpoint of municipal conditions, factory and commercial practices, rural customs and popular prejudices.

Then there must be careful studies in many places of the usual and occasional fauna of parasitic insects, and also of their capability of taking up and transmitting disease organisms.

Finally the time will arrive when there will be undertaken long series of careful transmission experiments in which the best coöperation of parasitologist, entomologist and physician or veterinarian will be imperative.

We are now beginning a period of reconstruction in our national life. Educational and investigational work of all kinds must be overhauled and developed to meet the spirit of a new time. Let us in entomology not be found backward in adjusting our science to new requirements.

Mr. W. D. Pierce: The laundry report in full, which is a co-operative report with the Quartermaster's Department, will be published in January. I do not know that it will be printed in any of the Entomological Journals. It gives an entirely new phase to Sanitary Entomology; that is, its application to industry. We have just found that by lowering the specific gravity of the oil used in dry cleaning establishments we can bring about control.

Mr. E. H. Gibson: I have been in charge of the insect work in one of our largest cantonments during the past nine months and wish to take this opportunity to express my appreciation of the excellent work and the interest taken by Dr. Pierce in activities along the line of insects in relation to health and for the class which he has conducted in Entomology.

Mr. W. A. Riley: In this connection, I feel compelled to say that it is unfortunate that many of these reports that have been made during the past few months are not going to be more widely available. At the outbreak of the war, Mr. Moore, of Minnesota, was asked to take up this line of work, and with thorough generosity, the authorities there gave him all of his time and all facilities for doing this work. He has published a few brief papers, and one of the very important ones which is about to appear is one showing that apart from disease transmission, the louse problem is of more interest to the medical man than has been supposed, that gross infection of lice is an actual cause of persistent fever, and in one case, one of those experimented on, it showed very serious results. We feel confident that if the man had been subjected much longer to the experiment, it might have resulted even fatally.

In other words, that without any disease transmission at all, the bite of the louse itself was a serious thing, when it came to gross infection, and we have since had a paper from a medical man who observed a similar case in San Francisco and who did not interpret it until he received these results. These reports of Mr. Moore's, of course, have been made constantly to the Bureau and to the authorities in Washington, but unfortunately they have not been published in any extended manner.

Mr. W. D. Pierce: It might interest the association to know that a complete bulletin will be prepared by the Bureau of Entomology on the louse problem.

Mr. W. C. O'Kane: Dr. Riley, in speaking of fever being caused by the bites of lice, I personally have had the experience of a pretty high temperature brought on by too many jiggers in South America, several hundred I imagine, followed by a fever lasting some days, etc.

Mr. W. A. Riley: It is a peculiar fact that this condition has

not been noted by any of the modern workers on the louse problem. There were a few references many years ago, in which there was some mention of fever in connection with lice bites, but there was no significance attached to it.

Vice-President W. C. O'Kane presiding.

Mr. W. C. O'Kane: We will now take up the discussion of the presidential address.

Mr. T. J. Headlee: I have been much impressed with the address of our president. He is advocating fundamental training along biological lines for persons who would enter the field of economic entomology. In this he does not apparently agree with many of the addresses and discussions hitherto presented to this association dealing with the problem of training economic entomologists. The attitude taken in many previous papers on this subject has been that the man prepared for economic entomology should be thoroughly trained in agriculture and in the direct technical side of his profession, the idea apparently being that unless he is familiar to a great extent with economic insects he is not in a position to measure up with men in other lines of scientific agriculture. As I see it, this is only a part of the movement in scientific agriculture which has taken place during the last ten years, the object and aim of which has been to produce men trained in the technical side of the science, without much regard to their preparation in fundamental science and the humanities.

It seems to me that this address of our president marks the swing in the opposite direction. I may say at once that I am in entire sympathy with this change of front.

In a few instances in the past ten years addresses have been delivered advocating training of a similar sort, but the bulk of teaching opinion has seemed to be on the other side.

From the beginning of economic entomology until the present and probably to a distant date in the future, the tendency to study the life history of economic insects, without regard to the nature of the environment in which they live, has been and will continue to be very paramount.

Professor Sanderson in his address as president of this association at Minneapolis some years ago advocated the idea of studying the economic insect not only from the standpoint of life history but also from the standpoint of its ecological relations and suggested that a standing committee on entomological research be authorized, the purpose of which should be to hold up ideals of economic entomological research. With the passage of time the activity of this committee became limited to the preparation of a list of the projects on which the members of the association are engaged. This, according to my view, is a mistaken

tendency and prevents the said committee from doing the very work for which it was originally appointed.

Mr. W. E. Britton: I think that excellent ideas have been brought out in the president's address and I agree with the remarks of the speaker who has just commented on it.

We have had a great many papers and a great deal of emphasis has been placed upon the necessity of having been trained in an agricultural college. So far as I can see, the chief reason for this has been, that men shall get the right viewpoint, that is a sympathetic one, with problems of agriculture. As you know, many of our colleges and universities have not especially induced students to take hold of economic problems. That is true not only in entomology, but in all other subjects. There has been a tendency to encourage work in pure science.

Now at the present time the pendulum has swung in the other direction; because of the necessities of war we have been obliged to solve many economic problems, such as problems of food production, ammunition making, poisonous gas-making, etc. So that for the past year or so nearly all of our efforts have been directed towards work which will be beneficial to us as a nation, or to mankind.

The present is an especially favorable time to begin efforts towards the solving of other problems which have a bearing on economic lines. So if we can use the two together, that is, have the broad foundation, and then direct efforts with the spirit which we now all possess, it seems to me that we may be able to get the greatest degree of efficiency in entomological research.

Mr. E. P. Felt: I want to express my appreciation of the president's address. It seems to me that he has touched some vitally important matters, and at a time when they could be discussed to particular advantage. As stated by the various speakers, we have been obliged to coöperate in order to win the war. We are learning what the other man can and is doing, and the proposition that I would like to emphasize in this connection is this: Is there any way in which these suggestions can be crystallized into something practical in the way of closer coöperation between entomologists throughout the country. Of course we are all independent, we do not like dictation, but if we can recognize that each, within certain limits, is a specialist along one or more lines, and work out some means whereby there will be effective coöperation, not only in entomology but associated sciences, we might bring about something of great value for the future. The difficulty has been to get a workable plan.

Mr. Z. P. Metcalf: It was not my good fortune to hear the presidential address, but there is one thought that might be worth

while for the members of the association. A few years ago Professor Herrick made the text of his presidential address that the worst weed in corn might be corn and the worst thing in a course in entomology might be too much entomology. The entomologist needs a broad foundation. I doubt very much if there are many other fields where a broader foundation is needed. This foundation should be laid in biology. At the present time there is too much emphasis on the more technical phases of agriculture and not enough upon the broad general principles of biology.

Secretary A. F. Burgess: It seems to me that we are all agreed that the entomologists should have a broad, liberal training as a foundation. After that has been secured, specialization is not only necessary but very desirable. In the field of entomology we find the activities greatly specialized. As time goes on entomology will become more and more specialized. The man who becomes expert in a special line of investigation must follow that line to the exclusion of other special activities. Dr. Ball brought out the fact that the San José scale had been responsible for the enactment of many of the state laws relating to insect control. Inspection work requires some things in which many entomologists have not been trained. A good inspector ought to have a short course in business administration.

Mr. T. J. Headlee: Doesn't he get it?

Secretary A. F. Burgess: He undoubtedly gets it by hard knocks but he gets it not only at his own expense but at the expense of the people that he is attempting to serve. There is another point brought out by the address of Dr. Ball relative to conditions in the future, and that is that our leaders or leader should be a man with broad vision.

I believe that is absolutely correct. The practical side of the problem, however, cannot be ignored. No matter how much vision a man may have, if he is tied down with a thousand and one duties which he has to perform in order to earn his daily bread, he does not have the time to work out and put in force ideas that may come to him and which would be of benefit to us all. It may help but it does not secure the goal for which you are striving unless it is somebody's business who has time to attend to that business to put the ideas into operation.

Mr. W. D. Pierce: Mr. President, Dr. Ball brought up some points in his address that have interested me very much. He brought before us visions of some of the big fields that entomology is to come to in the future; for instance, the extermination of the boll-weevil in the south, by the temporary suspension of cotton growing. This question has been considered a great many times. I don't doubt but that Dr. Ball is prophesying something that will take place some

time in the future. But before we come to anything like attempting those great big-scale tests, we have got to have entomology better organized, we have got to have our men trained up to handle things in big ways and handle them coöperatively. A task like that would mean an organization with millions of dollars to be used. I believe it is possible, just as Dr. Ball does, that some day the boll-weevil will be pushed back, and that we will push back many other pests out of our nation by coöperative work, just as the cattle tick has been almost pushed out of this country simply through organized effort.

Now we have almost pushed the pink bollworm out in the operations of this past year. I think we are going to come to the time when we will do bigger tasks, but we must get on the broad basis of coöperation and we must know our principles, we have got to be trained more broadly than in the past.

I want to make one correction to Dr. Ball's address, and that is regarding his statement that the boll-weevil has only one food plant. It has one other, a native wild plant which grows in the mountains from Guatemala to Arizona. We have found some of the native plants and woodlands of the south can to a limited extent serve as hosts for it, so that even if we did suspend cotton growing, we might find it in some of those other plants.

Mr. E. D. Sanderson: Mr. Chairman, as I have not had the pleasure of meeting with this association for some time and as I will not be able to stay through the session, I want to now express my appreciation of the president's address, because it is along lines which have always appealed to me.

The matter of training is one to which more attention may well be given. At various sessions we have considered courses for graduate work and study. It seems to me the association might give more serious thought to graduate training in entomology, possibly through a committee. I think the graduate training in the technical branches of agriculture is one of the weak points of agricultural education. More and more men are going, not to agricultural institutions, but to some of our leading universities for graduate work in the pure sciences, and I feel that the agricultural institutions have not had a large enough vision of the training necessary in graduate work. There has been too much tendency to look at the technical aspects of the subject and not enough to fundamentals.

It was my good fortune a couple of years ago to have a course on the logic or method of science—rather an abstract thing many of you will think—but I received more from that course than almost any other course I have had. I had been working in science for some years and I thought I knew something about science, but I had never given the

matter serious thought of what was the method of science. In talking with a good many men and experienced scientific workers, I have come to the conclusion that if a great many of us had that foundation point of view which we get by considering the logic of science, it would be worth a great deal to us. I think every student ought to have some training along that line.

There is another matter on which I want to touch briefly, that is this matter for organization in putting over some of these big entomological undertakings. The boll-weevil has been referred to and that is a matter which has always interested me, because I was actively engaged in combating it some years ago.

The start, in a way, of the big extension movement in agriculture, which we have today, was from Dr. S. A. Knapp's work in Texas, in trying to fight the boll-weevil. He didn't know anything technically about the boll-weevil, but he was a mighty canny student of human nature and he demonstrated a method of fighting the boll-weevil which developed into the demonstration method that has gone on, until we have our present agricultural extension system. I don't mean to say that was the only basis of our present extension work but it was one of the largest factors in it. Now then, why didn't we as entomologists do that? Why didn't we show the people of the South how to fight the boll-weevil and why was it that we didn't get one job across instead of letting some other people do it for us? I have often thought of that.

I simply cite that because it has been mentioned and it is such an historic instance. The point is that today, as has been pointed out, the science is getting so large that there must be specialization. It is perfectly useless, in my humble judgment, to put a man who is a natural research man and who has been trained for minute laboratory research in charge of a big extension job. Occasionally you get a genius who can do anything, but most men aren't built that way.

Most men are better at some particular line, research, extension, or teaching. And it seems to me that that must be recognized, and that in any of these big undertakings we must make a study of the human nature factor and we must put the man in charge of that line of work who is willing to devote himself to that sort of thing. He may be a relatively mediocre research man, but if he is associated with a research man and he knows how to take the results of research to the people and "get them over," as we say, he is as valuable to science as the other man, because after all no piece of investigation is done until it is actually put into practical operation. An experiment or a demonstration is never done until the people actually use it, and if it isn't worth using the investigation, in so far, is incomplete, because it has not produced practical results in use. So I think there must be greater division of labor, which, of course, is coming about very rapidly.

Mr. H. A. Gossard: Mr. Sanderson has very nearly said one or two things that I thought I would like to say. The visions that Dr. Ball holds up have always been a very attractive sort of thing to the entomologist and it looks as if we ought to be able to do some of the things that he suggests. We will be able to do them by and by, but there are some things we must learn to do, in coöperation with people who are not entomologists at all, before there is any hope of accomplishing such things. We cannot, for instance, exterminate the boll-weevil, and there are a great many other things that we are failing to do—because for some reason, good or bad, we have not secured the coöperation of the powers that be, to the extent that we can do justice to large sections of people and to the individuals composing such sections and at the same time accomplish our projects. Until we reach that point where we can do justice to the cotton grower who is deprived of his privilege of growing cotton, not alone do justice to the cotton section, but to the individuals in it, there isn't much hope of putting a thing of that kind across. In other words we must coöperate with economic workers, sociological workers and perhaps with constitutional lawyers. Anyhow we must do a coöperating "stunt."

Now there is no use talking about an entomologist getting an education that will fit him to draft the laws, etc.,—he may not be even able to organize a system to carry these into effect, but he will have to learn to coöperate with the people who can before there is any reasonable hope of accomplishing these things, and whenever we do coöperate fairly, there is a reasonable and a practical basis for such a hope.

Capt. E. H. Gibson: Mr. Chairman, it has been my pleasure to attend a number of these meetings and to hear various very admirable presidential papers. No doubt there have been results come from each one of these but I contend that we have not had enough positive, direct results.

Now, Dr. Ball has given us many suggestions, and the remarks that have followed by Dr. Headlee, Dr. Felt and others, all tend to the right direction. Let me suggest, if I may, that this association have a committee which might be termed an entomological training coöperative committee, if for nothing more than to offer its services to the various colleges and universities throughout the country, for the purpose of bettering the fundamental training of the entomologist.

I would lay this suggestion before the older members of the association, men who have had more experience in the profession than I have, to make a motion to this effect, if they see fit. I think the time is ripe to do that. It may not be well to have this committee formed immediately, but I believe a definite step should be taken to carry out the suggestion that Dr. Ball and the other members have made this

afternoon, regarding the betterment of the training for future entomologists.

Mr. T. J. Headlee: I move that a committee of ten men be appointed as a standing committee on entomological policy; two men to retire each year and be replaced by two others.

The duty of this committee will be the consideration of the various problems that have been raised. We have a committee on agricultural policy in teaching, and research, and these committees met a long-felt need. We are a national organization and are supposed to be leaders in entomological thought. Such a committee could serve the association and be a body from which suggestions would come and be put into operation as they are authorized by the association.

The motion was seconded by Mr. G. A. Dean.

Mr. W. J. Schoene: I would like to suggest that the president be a member of this committee so that the suggestions which he may have can be acted upon by the committee.

Mr. G. A. Dean: Dr. Ball has presented to this association a paper that I have wanted some one to present for the last four or five years. I wanted it to come from a man who not only has had fundamental training in science, but who has also had many years' experience in the different branches of entomological work, such as the experiment station, the college or university, the extension and the regulatory. I have listened with great interest to the discussions from men who are experiment station entomologists, extension entomologists, state entomologists, entomologists in charge of teaching in colleges and universities, and entomologists in charge of regulatory work, because in the institution with which I am connected, the head of the Department of Entomology is in charge of all these different lines of entomological work. I seconded the motion because I feel very keenly that a committee of this sort could bring about or formulate a plan that would be of much help, not only to those entomologists who are in charge of one particular line of work, but also to those of us who are in charge of the various lines. I do not believe we can overemphasize the importance that Dr. Ball has laid upon the fundamental training of men for entomological work.

There are men in this meeting who were in my classes at the time when only a few courses were offered in entomology. They have done some excellent work. Again, there are men here who received training along some particular line, but were compelled to do entomological work along another line. They, too, have made good entomologists. Why have these men succeeded? In my mind, simply because they were able to get strong courses in other departments, and with this fundamental training, together with good minds, were able to do

research work. One of the best teachers I ever had in entomology did his major work in zoölogy. This simply emphasizes the points brought out by Dr. Sanderson, that you cannot expect a man who has had special training along just one particular line to succeed in others unless he has had first the fundamental training in science.

If a man has had deep and fundamental training, and has the brains and capacity to do research work, I don't care whether he had twice as much zoölogy, chemistry, or physics than he had of entomology, he will make a valuable man in entomology, providing, as I said before, he has the proper stuff in him to make an entomologist.

There are men here, who, when they were students in my department, complained because they were urged and even compelled to take more chemistry, physics, plant pathology, agriculture and German, because they felt that they were not getting enough entomology. I am sure that these same men now feel that these subjects have contributed much to their success.

President Ball resumes the chair.

Mr. W. C. O'Kane: This whole subject is one that is vitally important to every man here. We have listened to a splendid address by Dr. Ball, and in past years to other helpful addresses that bore somewhat on the same subject, including those by Sanderson and by Herrick. But we haven't yet carried the thing through to that which is concrete. If Dr. Headlee's plan of a committee of ten can materialize into something substantial, it will be a real step forward.

We have spoken of the need of more fundamental, broad training for entomologists, and at the same time we urge specialization. These two things may seem to be incompatible. But are they? Do they not go together? In other words, should a man not have a broad foundation to start with and should he not then specialize in the particular line to which he is adapted? I wish that entomological training might be on the same basis as that of doctors; that a man might have four years of broad collegiate study and then have three or four years of specialized training after that. You can't put both of those things into four years of college. That is our fundamental difficulty in entomology, just as it is in various other professions.

In our investigational work we need to seek more of the coöperative help of investigators in other lines.

There are very few of the big problems today in entomology that do not include phases of chemistry or meteorology or physics or botany. The specialists in those lines should share in the inquiry. Take the problems that Dr. Ball has mentioned here. Practically every one of them should be undertaken as a coöperative project, with competent specialists working with the entomologist.

Vice-President O'Kane take the chair.

President D. E. Ball: I believe that Dr. Headlee's plan is better than the one I offered. A committee with each member serving five years will give opportunity for the maturing of a policy and its adoption by the association; and still leave time enough for carrying it into effect by the men who had the vision to plan it.

The present executive committee made up of the officers of the society changes practically its entire membership each year. It is impossible for a group of men to take up fundamental problems and accomplish anything in a single year.

The executive committee of the American Association of Agricultural Colleges and Experiment Stations is a practically permanent committee with a permanent chairman. The valuable work accomplished by that committee in obtaining support for work in agriculture, as well as coördinating and strengthening the agencies engaged in its development, is a striking example of the efficiency of that type of an organization.

This committee of ten can be organized into smaller committees to take up different lines of policy. A sub-committee might, for example, take up the standardization of courses of study for the training of entomologists. A statement of the fundamental requirements of such a course endorsed by this association would be very helpful to those of us trying to establish the right sort of training in our respective institutions. Such a committee could take up the problems of research, of publication, or any other factor of importance to our science. No such results can be secured from our present type of organization. I looked over the situation at the beginning of the year and did not consider it worth while to attempt anything. We are coming to a point where we must have a strong organization and now is the time to start the movement.

One of our sister societies is already putting an international organization in the field. The Economic Entomologists have done more to internationalize their science, than any other organization. Would it not be a good idea for this meeting to formulate a plan for an inter-allied federation of entomological workers?

In conclusion, I wish to urge strongly the adoption of Dr. Headlee's motion. Let us have a practically permanent committee on Entomological Policy.

Mr. E. P. Felt: I believe there is a field for this sort of a committee. I have a feeling, however, that if we are going to have a strong organization, that eventually it should not be as a special committee on policy, but it should be an executive committee, with a term of years in office. The defect as Dr. Ball has pointed out is this: That the officers responsible for the conduct of the association are

mostly annual. I would like to see a committee appointed with a fairly permanent tenure of office, to take up this matter now, and also go a little bit further and see an amendment to the constitution which would result in remodeling our Executive Committee and at least have a majority—perhaps of this committee—swung over into the Executive Committee by due process and be responsible for the general policy of the association.

Mr. Z. P. Metcalf: I move that the motion be laid upon the table until the business session. We have several conflicting views and as this is a very important matter, I think it ought to be considered thoroughly before action is taken. The suggestion, I believe, is a good one, but better results will be secured if careful consideration is given before the motion is adopted.

By vote of the association, the motion was laid on the table until the business session. Final action on this matter will be found in Part I of this report.

President E. D. Ball resumed the chair.

President E. D. Ball: The next paper will be by H. A. Gossard, entitled, "The Ohio Wheat Survey."

THE OHIO WHEAT SURVEY

By H. A. Gossard, *Wooster, Ohio*, and T. H. Parks, *Columbus, Ohio*

For two seasons Ohio farmers have had the results of a state-wide survey of wheat enemies to guide them in deciding if wheat growing would likely be a safe agricultural project and when the seeding could most advantageously be made. The plan of operation, the cost of the work and the results obtained may be items of considerable interest to the wheat-producing states, while states largely engaged in the production of any important agricultural staple or staples will doubtless find material of interest in this review.

General Plan of the Survey

The survey of 1917 was organized and directed by the senior author, that of 1918 by the authors conjointly. Back of both surveys was the cordial endorsement and help of the entomological departments of the State University and of the State Department of Agriculture, without which aid it would have been practically impossible to carry the project to success. Field surveyors were drawn from all these departments and all had a share in financing the last survey though the first was financed wholly by the Experiment Station.

The idea behind the survey has been not to make it deal exclusively with wheat insects, but to gather at the same time as much knowledge

as possible regarding other pests. We timed the work just before the wheat harvest so as to insure, if possible, results of value sufficient to justify the expenditures made, and hoped at the same time to gather information regarding other pests sufficient to give us a comprehensive entomological perspective of the entire state. Definite knowledge of the kind sought is useful at all times, especially so in war time. Entomological surveyors competent to do the work and in sufficient numbers to accomplish it have only been available in Ohio at the close of the spring semester at the University when a number of advanced students in entomology become available and are glad to obtain a summer's experience in field practice. We give the young men a course of reading and have them examine specimens in our collection and do some work in the wheat plots on the Station farm and in fields near Wooster before sending them out. Also we plan to have them work for a few days with experienced entomologists before sending them to do independent work.

In 1917 we commenced at four points along the southern border of the state a short time before harvest and four lines were run from these points more or less parallel with each other to the northern border of the state. Only one of these lines was surveyed entirely by automobile, the other three being selected with reference to easy railway connections from south to north.

No matter which plan was used, each surveyor was instructed to spend about one day in each county assigned to him. Although his route was mapped, he was given some latitude in going a county or two to the east or west of the indicated route in case entomological discoveries or reports indicated to his judgment that this was desirable. The stopping places selected were generally county seat towns in which were the offices of county agricultural agents. These agents were advised beforehand by letter of the survey being made and their willingness to coöperate in the work proved a great help not only in directing the surveyors to the most important wheat districts of their counties but in keeping down the expense to the state, for many of these agents placed themselves and their automobiles at the disposal of the surveyors, thereby shifting part of the cost to the counties.

In 1918 we arranged to do as much of the work by automobile as possible since we had found this to be the cheapest and most efficient method of doing the work. Only two men used the railroad plan this season and their territory was restricted to a small number of counties. Either automobiles or livery teams were employed by these two men to carry them from field to field.

In both surveys, from ten to twenty-five fields, or a few more or less, were taken to represent the county and these were located on as long

a circuit as it was possible to cover in a day. The practice of the surveyors in getting the records varied according to circumstances. In western Ohio where the jointworm was prevalent and Hessian fly more numerous than in other sections, accurate counts of infestation were made from every field investigated in both seasons. In 1917 an indefinite number of straws from each field was taken and the percentage of infestation calculated. The samples would range from a few less than 100 to considerably more than 100 straws. In the same territory, during the survey of 1918, exactly 100 straws were counted and pulled from each field and one man made the count seated in the back of the machine while another drove from five to ten miles before making another stop. About eighty miles per day were averaged for each county and about ten fields in each were examined. Counts were made for both Hessian fly and jointworm.

In the northeastern part of the state where there was less of Hessian fly and a different species of jointworm, *Isosoma vaginicolum*, a somewhat different plan was followed. Here each surveyor was usually working alone and therefore could make no examination while driving from one field to another. Counts for jointworm were made in most of the counties, but this was not so necessary as with *Isosoma tritici*, because most of the infested straws are discernible from a short distance, and a practiced surveyor can estimate with approximate correctness the percentage of infestation within a radius of six or eight feet around the point where he is standing. Also when repeated examinations discover only an occasional flaxseed of Hessian fly, which counting reduces to less than 3 per cent, the surveyor is apt to feel that he can get a more accurate knowledge of the county he is working by quickening his pace and examining in total a much larger sample than 100 straws from each field. He can then visit twenty or more fields in the county during the day, making an approximate estimate of the percentage of infestation and occasionally checking his estimates with an actual count. The chief defect with this method lies in the fact that the indefinite results do not furnish a good basis for comparing conditions from one year to another and the gradual upgrade of an incipient outbreak would be less easy to detect than if there was a definite record of actual counts from every county through a series of years. Whether 100 straws from ten to fifteen fields strung over a county really furnish a substantial foundation for a significant record we cannot yet tell, but Mr. Houser who has worked the western area both seasons and has had extended experience with both *Isosoma tritici* and Hessian fly thinks the records, meager as they admittedly are, really possess a dependable significance and will become increasingly valuable if the survey is continued through a series of years. Con-

siderable attention was given to the wheat midge the past season as it was widely distributed, but we found no definite method for recording the exact degree of infestation. Other insects were made the subjects of inquiry as indicated on the daily report blank used by the surveyors and exhibited herewith. Also a blank report was filled out for each wheat field visited (blanks attached).

Cost of the Survey in 1917

In 1917 one of the surveyors spent eleven days in the field using an automobile exclusively for all travel. He succeeded in hiring a Ford at $4.50 per day for this use, making the automobile cost $47.25 and the cost of his maintenance for the period was $22.40. His total expenses in surveying sixteen counties was $69.65, or a little more than $4 per county.

The other three surveyors traveled by rail from county to county and either hired automobiles or livery teams for the actual field work or else were taken in charge by the county agents who arranged for transportation.

One of the three surveyed eleven counties at a cost to the Station of $77.25. To this should be added the transportation costs borne by the counties and of which we have no record. They probably amounted to $50.

A second surveyed twelve counties at a cost of $111.68. Again to this should be added an estimated item of $50 which was borne by the counties.

The third man working by rail covered thirteen counties at a cost of $104.55. We estimate that $60 should be added to this amount as the item borne by the counties. A few counties such as Wayne, in which the Experiment Station is located, were surveyed incidentally without cost to the state other than the time of the entomologists which was covered by their regular salaries.

The total cost to the state and counties of the survey made in 1917, exclusive of the salaries of the surveyors, was $463 as closely as we can determine. Allowing three weeks as the average time worked by each surveyor, the total cost, salaries included, was $1,048 as nearly as can be determined. This figure includes the salary of the Director of the Survey as well as of the field men, though most of the Director's time was given to other matters than the survey while it was proceeding. Out of our eighty-eight counties, fifty-six were entered and we obtained rather meager but first-hand information as to conditions within them. The counties not entered were, many of them, between the parallel lines of survey, and others were not important wheat-producing counties. We obtained such information from them as could be

gleaned from questionnaire blanks sent to the county agents or county food commissioners in case there were no agents.

Results of the Survey of 1917

Was this expenditure worth while? Part of the answer can be found in the results with the potato aphid. Mr. Houser ran into the worst area of infestation in the first county on his route, and arrangements were at once made for stationing a man in this field for detailed study of the species. Bulletin 317 of the Ohio Station by Messrs. Houser, Guyton and Lowry, review the results of this effort. County Agent Van Atta reported that spraying demonstrations were conducted with growers whose total plantings aggregated 308,000 plants. By very conservative estimates over 30,000 bushels of tomatoes worth $1 per bushel were saved to this county by proper spraying. Since the College of Agriculture and the Kentucky Tobacco Product Company each had a representative also assisting the county agent we evidently can claim only part of the credit for this saving; but we need to claim only one-thirtieth part of it to find payment for the entire state survey and I am very sure none of the workers participating in the aphis fight would put our part in the total result at so low a fraction. As an after result, the publication of this bulletin made possible an intelligent fight against the pest during the season of 1918 and in all likelihood $50,000 is a small estimate of the values conserved the past summer as the direct result of its publication.

Because we were able to assure our farmers that there were no large areas overrun with Hessian fly and were able to locate the joint worm areas, the survey contributed a good deal toward increasing the wheat acreage in the fall of 1917. The State Department of Agriculture reported an increase of 10 per cent in acreage and part of this must be ascribed to the fact that our farmers were not fearful of the results if they seeded a few days earlier than usual and were therefore able to use their time to greatest advantage, an important matter when the labor supply on the farms was very short.

Cost of the Survey in 1918

In 1918 the work was more thoroughly done than in the preceding year. We entered and explored with some care, as previously described, seventy-three of our eighty-eight counties. The omitted ones were not important wheat-producing counties and were rather difficult of access. One of our surveyors spent twenty-four days in the work, traveled 1,894 miles, surveyed twenty-four counties and expended for machine hire and maintenance $168.36. An assistant who accompanied him and also surveyed a route of his own, including five

counties, expended $80.41. A third man who had the longest and roughest route of any spent twenty-seven or twenty-eight days in the work, looked over twenty-five counties, and spent $175. Six other men participated in the work, in some cases spending only a day or two in their home counties, in other cases surveying five or six counties; but in these cases each county was a separate undertaking and disconnected with any other trip.

The total cost of the survey of 1918, exclusive of salaries, was $578.45. With the salaries and wages of all the workers included the cost was approximately $1200. These expenses were born coöperatively by the Experiment Station, State University and the State Department of Agriculture.

Results of the Survey of 1918

It is yet too early to fairly appraise the value of the past season's work. Near the conclusion of the survey, potato aphis was encountered in damaging numbers in northern Ohio and spraying demonstrations conducted as in the previous year. Investigations later made by the Extension Entomologist over ten widely separated counties revealed the presence of 65 to 80 per cent parasitism among *Isosoma tritici*. The location of areas inhabited by chinch bugs has enabled the Extension Entomologist to concentrate attention upon this insect, while information about other insects collected by these trained entomologists has been of much value in forcasting extension problems which can be better dealt with in their incipiency. That we were again able to allay the fears of our wheat growers regarding any disastrous menace to the 1919 crop is part of the explanation for the increased acreage put out the past fall, notwithstanding the shortest labor supply we have experienced in many years. We were able to definitely encourage increased plantings in northeastern Ohio and hold out the hope of a reduced infestation from jointworm everywhere in 1919. The location of the areas inhabited by chinch bugs has enabled our Extension Entomologist to concentrate attention on these districts. We were again able to shoo away the Hessian fly bugaboo sufficiently from more than half of the state to enable the farmers to take advantage of all their available time. We will doubtless find some neighborhoods and sizable districts outside the territory where we counseled caution that will produce too much fly because farmers hurried their seeding a little too much, but we cannot now see any state-wide threat to our next crop and believe the total harvest in bushels next summer will be much greater than if we had held all our growers back because of lack of definite knowledge.

Possible Results from a Series of Annual Surveys

The immediate object of the two surveys completed was to obtain definite knowledge regarding the distribution of wheat pests, especially jointworm and Hessian fly so we could furnish reliable and immediate advice to our farmers as to the risks they were taking in the various quarters of the state if they seeded wheat and to tell them how to minimize the damage. The date for seeding, also cultural and fertilizer practice were recommended on the basis of our findings. This information was disseminated by letters to all the county agricultural agents, through press bulletins, by special articles in the agricultural papers and through special reports printed in the September monthly bulletins of the Agricultural Experiment Station which reach about 50,000 farmers.

Results with other insects, such as the Potato aphid, were given out somewhat differently but knowledge gathered about them should be considered an immediate result of the survey.

But large-scale and long-term observations of this kind can possibly throw some light on such questions as these: What percentage of infestation constitutes a Hessian fly menace? Can a severe outbreak of Hessian fly approach undetected in a state where such surveys are made annually? Is a 3 per cent infestation a menace sometimes when a 20 per cent infestation is not at other times? Do weather conditions or parasitic "wheels within wheels" determine the increase? Is the menace greatest from nearby localities with ordinary infestation or from great areas of highly infested stubble at a long distance away? If extensive migration occurs, does the fly-free date, fixed for a given point by experimental sowings or by the law of latitude, altitude, etc., remain effective for this point, with a badly infested large area fifty or seventy-five miles to the south? If the data we are securing are too meager to answer such questions, how much more do we need, and of what sort, in order to obtain the answers desired?

Mr. T. J. Headlee: There are two questions that I would like to ask the speaker. Does the pink and green aphis of the potato and tomato appear on these plants in small numbers, then gradually by normal increase, create the serious infestation, and is it possible to find a time before the plants assume a recumbent habit of growth when the lice may be destroyed by ordinary potato and tomato spraying machinery? Did the speaker attempt to destroy these lice by spraying?

Mr. H. A. Gossard: I will ask Mr. Houser to answer that.

Mr. J. S. Houser: We can detect an outbreak of the pink and green potato aphid at an early stage and particularly during the earlier

part of the season. In other words, an outbreak seems to be a development from small, initial colonies which gradually accumulate a momentum which we finally term a scourge. Later in the season, there is some reason to believe that migrating swarms suddenly appear and heavily infest an area within a brief time. On potato, the topmost leaves are affected first and at the outset do not curl. On tomato the infestation is sometimes carried from the seedbed, but in most instances the plants become infested after they are set in the field. We have told our growers that when plants six to eight inches high bear 20 to 40 aphids it was time to spray.

The scourge usually starts first in southern Ohio and gradually works northward, there being about a month's difference in the time the insect is seen in the southern sections and its appearance along the lake shore.

As to the treatment: we have found nicotine sulphate used at the rate of $\frac{3}{4}$ pint to 50 gallons of water with enough soap added to form a good suds to give good results. The amount of soap varies with the hardness of the water, but on the average two pounds of hard laundry soap is adequate. A power sprayer is used with three large disk nozzles to each row, one spraying directly downward and one on each side of the row set at an angle to spray upward in order to reach the insects upon the underside of the leaves. Such an apparatus is useful only so long as the potatoes or tomatoes are standing upright.

Mr. T. J. Headlee: What pressure do you use?

Mr. J. S. Houser: We used from 125 to 175 pounds per square inch.

Mr. H. A. Gossard: How many applications?

Mr. J. S. Houser: It sometimes takes three sprayings to subdue a scourge.

Mr. T. J. Headlee: Engine driven sprayers?

Mr. J. S. Houser: Engine driven sprayers are better but in one case we obtained good results from a traction driven machine.

Mr. T. J. Headlee: We have, during the past year, used against the pink and green aphis an engine-driven potato spraying machine, applied a mixture composed of 1 part of 40 per cent nicotine to 500 parts of water and soap at the rate of 2 to 5 pounds to 50 gallons, used a little better than 100 gallons to the acre with a pressure of 250 pounds and obtained excellent results in the destruction of the aphids.

Mr. E. N. Cory: In Maryland we found that the infestation of aphids on potatoes was a fair indication of what we might expect later on the tomatoes. An examination of tomato seedlings is also a fair indication. We have not found it necessary to spray the potatoes.

Mr. H. A. Gossard: I may mention one little trial that I made

this last summer against the potato aphid, using the same strength of sprays; I used a gasoline engine pump, giving about 100 pounds pressure and a rubber trailer, just the ordinary trailer hose. I guided the nozzle by hand and sprayed three or four rows of potatoes on each side of the sprayer. One application directed by hand against the lice cleaned them up in good order.

Mr. T. J. Headlee: How many gallons to the acre did you use with that apparatus?

Mr. H. A. Gossard: I used about 200 gallons or something like that on an eighth of an acre.

Mr. T. J. Headlee: The year before last we used an ordinary sprayer against the false cabbage aphis on turnips which were 12 inches high and had assumed the recumbent habit. We found that by the time the lice were thoroughly wetted we had used 1,500 gallons to the acre, making the cost of the application so large as to render the treatment impracticable. With an engine-driven potato sprayer equipped with a lifting device we were able to cover plants of the same size with a little more than 100 gallons of spray mixture to the acre and to get excellent results in control of the aphis.

Mr. W. E. Britton: I would like to inquire if this treatment was given for the aphid alone?

Mr. H. A. Gossard: In most instances the sprays I used were combinations of nicotine, lead arsenate and Bordeaux. I didn't use soap where I used the Bordeaux.

Mr. W. E. Britton: Did you use the sulphur in the nicotine?

Mr. J. S. Houser: Most of the experimental work that we did was conducted from the standpoint of aphid control alone and not from the standpoint of developing a combined fungicide and aphicide. We therefore used no copper sulphate or lime sulphur, but employed nicotine sulphate, soap, etc., in various strengths and combinations.

President E. D. Ball: The paper by Mr. R. W. Chapman entitled, "Insects Affecting Wheat Flour and Wheat Flour Substitutes," will be read by Mr. W. A. Riley.

INSECTS IN RELATION TO WHEAT FLOUR AND WHEAT FLOUR SUBSTITUTES[1]

By R. N. Chapman, *University of Minnesota.*

The ruling of the Federal Food Administration requiring the purchase of wheat flour substitutes with wheat flour called for the milling

[1] Published with the approval of the Director, as Paper 165 of the Journal Series of the Minnesota Agricultural Experiment Station.

and marketing of coarse flours in larger amounts than had ever before been attempted. The large flour milling interests of Minnesota predicted insect trouble and later the wholesale Grocers' Association and the Bakers' Association asked for help in protecting their stocks of wheat flour substitutes from insects.

In response to these requests work was carried on along two lines; the first, to meet the existing emergency by devising methods of protection, and the second, a study of the ecological relations of insects and the various flours and cereals. The relative susceptibility of different flours to insects is of prime importance in protecting them from insects, and a knowledge of susceptibility should be the foundation for a knowledge of protection.

The emergency work was mainly concerned with the consumers, for millers adopted measures of rapid transportation calculated to move the products to consumption before the eggs, if any were present, could hatch and cause damage. Circular letters issued through the office of the Federal Food Administration from Minnesota urged dealers to adopt the miller's plan of rapid handling and emphasized the necessity for cleanness in their warehouses.

The consumers did not benefit by the millers' and dealers' methods of rapid handling except in cases where only a few days supply of substitutes was on hand at a time. Where it was necessary to purchase larger supplies, the situation was most serious, for the rapid transportation often brought the eggs to the consumer all ready for hatching.

Housekeepers were advised to heat all their substitutes as soon as they were brought into the home in order to kill any eggs or larvæ which might be present. A method of heating to obtain a temperature fatal to insects and yet prevent the cereal from injury by overheating was devised as a result of a series of experiments. The temperature curves show differences in the different ovens used; but in all cases it was found that when the cereal was less than two inches deep in pans, and heated slowly until the surface temperature reached 85° C., the source of heat could be turned off, in the case of a gas, gasoline, or kerosene stove, or the oven door opened in the case of a coal or wood stove, and in the course of half an hour, the heat would diffuse throughout the cereal until all parts of it had passed well above the fatal temperature for insects.

For obtaining satisfactory results, it is essential that the cereal should be less than two inches deep in the pans, that the heating be done slowly with the fire as low as it will burn well in order to allow for the conduction of heat throughout the cereal, and that the heating be

stopped before a temperature has been reached which will injure the cereal (between 90° and 100° C.).

Since high temperature thermometers are not available for all housekeepers, a mixture of carnauba wax and paraffin has been devised which melts at the proper temperature for the surface of the flour. It is not the exact point at which the wax melts, but the melting of the piece of wax to a grease spot that is taken as the indicator. Therefore the piece of wax measures, not only the temperature attained, but also the time required for a certain amount of heat conduction, until the entire piece of wax has melted. Since temperature and time for heat conduction are the factors concerned in the uniform heating of the cereal, the wax may be even more satisfactory than thermometers, which register temperature only.

In practice, the method has proved to be very satisfactory, and is now being used in several states. When methods of rapid transit are followed systematically by the heating of cereals as soon as they are received by the consuming public, the losses which insects cause to these flours and cereals will be reduced to a minimum.

There are, however, certain difficulties to be contended with in the introduction of this method. The public must be acquainted with the method and impressed with its importance; in this the Federal Food Administration for Minnesota has coöperated. The wax must be made available for all, and in this matter the wholesale grocers cooperated in supplying their trade throughout the state, yet there were frequent complaints from those who were unable to obtain wax. To supply the demand the wax must be manufactured at a reasonable cost and yet conform to the requirements as to melting point and size of pieces. This matter has required constant attention but may now be placed on a more satisfactory basis when industry has returned to conditions of peace.

The bakers have experienced heavy losses and have required special attention and methods. Education in matters of cleanliness and a reform in some matters of handling flour have yielded good results. The exchange or refilling of used sacks has been found to be the source of much trouble. Experiments have shown that when empty sacks are placed in the oven, three or four deep on boards and left for five minutes, all the insects in them are killed at the usual temperature of 232° C. While it is necessary to watch the sacks closely to prevent scorching, this practice has given great relief. All rye proofing boxes and other utensils have likewise been heated in the oven with a result that badly infested bakeries have been entirely freed from insects.

The study of the relative susceptibility of the various flours and

cereals has consisted of experimental work in the laboratory and observational work in storehouses. The experimental work has proceeded on the assumption that other things being equal, susceptibility may be due either to the attraction which a cereal may offer to insects, influencing the number of insects which might invade it in the first place, or to the rate of development of the insects after entrance, which might result in an accumulation of the insects in great numbers.

In the study of the invasion, the various flours were placed in cylindrical jars with removable partitions, which divided each jar into five equal sectors. A different flour was placed in each sector, the partitions were removed, and the insects were placed in a depression in the center of the jar. Being thus surrounded by equal amounts of the different flours, the insects were free to express a choice if they had any.

The experiments were carried on in the dark and extended from a few hours to several days, the length of time making little difference after the first few hours, when the insects were exploring about. When an observation was to be made, the partitions were replaced and the contents of each sector removed, to count the insects contained in it. When one hundred insects were used in the experiment, the number found in a given cereal would be the percentage of relative susceptibility of that cereal as compared with the others used in the experiment.

The relations of *Tribolium confusum* to five grades of wheat flour and various wheat flour substitutes were studied in this way. The results of 25 experiments with adult beetles showed the following percentages: 1st Sizings, 10.6 per cent; 1st Middlings, 11.5 per cent; 1st Low Grade, 12.4 per cent; 1st Tailings, 14.6 per cent; 5th Bran, 52 per cent. The coarseness of these flours varies in the order named from the fine sizings to the bran. The experiments with larvæ did not show a variation greater than 7 or 8 per cent on either side of 20 per cent, the expectation, and consequently show no preference, for an average of about one-fifth of the total number of larvæ were found in each sector.

The results with the wheat flour susbtitutes showed no percentages constant enough to denote decided choice, either among the various substitutes or as compared with low grade wheat flour, so long as the coarseness remained about equal in all cereals. When the bran from rye meal was introduced into the experiments a decided percentage was noticed. It contained an average of 36 per cent of the beetles and was very constant, while the percentages found in the other portions were small and subject to greater variation. When coarse corn meal was used, no increase in percentage was found.

It seems, therefore, that a coarse, flaky material is more attractive

than a fine or granular material, and that the element of flakiness is, so far as choice is concerned, dominant over nutritive differences, if nutritive differences exist. To check this, some bran was ground to fineness and given an equal exposure to the beetles with the coarse bran. An average of 60 per cent of the beetles were found in the coarse bran and 40 per cent in the fine bran. Again four sections of a jar were filled with fine sawdust and the fifth with coarse sawdust. The sector with the coarse sawdust contained an average of 43.3 per cent of the beetles and the other sections averaged 15.3 per cent, 13.6 per cent, 12.2 per cent and 14.6 per cent respectively. It may therefore be concluded that the factor of coarseness is dominant and the factor of nutritive choice, if measurable, is less significant.

In the study of the relative development of the insects in the various wheat flours and substitutes, it was found that the larval life might be prolonged in certain wheat flour substitutes and that this prolongation took place in the last larval instar. In some cases the life-cycle was twice as long as in other cases. These experiments were all carried on under the same conditions, in an atmosphere of 70 per cent of relative humidity. (The temperature curve on the chart shows a drop of a few degrees near the end of the experiment, with a consequent prolongation of some of the pupal stages.) Further experiments now under way will furnish additional data on relative development.

The data accumulated from examinations of flour in warehouses have not yet reached the proportions which will give significant percentages, but the above results combined with general experience make it seem that coarseness is a factor in susceptibility. The fact that coarse cereals cannot be bolted through fine cloths together with the choice of the insects as shown in the invasion experiments substantiates this contention. The factor of relative development must await further investigations before its importance in influencing susceptibility can be judged.

Mr. T. J. Headlee: Were any chemical studies made of the effect of heat on the flours, or feeds?

Mr. W. A. Riley: There were a number of experiments carried on, both by the chemists who were interested in the general effect on proteids and also by the home economists of the department, showing that there was no injury at this temperature.

Vice-President W. C. O'Kane: The next paper will be presented by Mr. W. E. Britton.

KEROSENE EMULSION VERSUS NICOTINE SOLUTION FOR COMBATING THE POTATO APHID

By W. E. Britton and M. P. Zappe, *New Haven, Conn.*

The outbreak of the potato aphid (*Macrosiphum solanifolii* Ashmead) was so severe in Connecticut in 1917 that much damage was done by it, or at least attributed to it, and the crop greatly lessened. Consequently we watched for this insect in 1918, and on its appearance warned the growers to be prepared to spray as soon as it promised to become sufficiently abundant to cause injury.

The first aphids were noticed at the Station farm, Mount Carmel, on June 11. Three days later (June 14) they were more numerous, and some were producing young. On June 15, they were observed to be present in potato fields in Greenwich. On June 18, a warning was sent out through the press associations. For several days thereafter, there seemed to be only a slight increase in the numbers of aphids, but during the last days of June they increased much faster and it was evident that something must be done to check them. Consequently on July 2 and 3 the potato field was sprayed with Bordeaux mixture, lead arsenate and nicotine solution, using "Black Leaf 40" at the rate of one-half pint in a barrel (fifty gallons) of the mixture. Though this spray killed some of them it was not very effective, as the waxy nature of the aphids repelled the spray causing it to roll away in drops.

We conducted several small experiments in hopes of finding some inexpensive material which could safely be used as a spreader in combination with the Bordeaux and lead arsenate. In this we were not very successful, and nothing seemed to take the place of soap which is commonly used when spraying to kill aphids only. Apparently there is always some danger of using soap in the combination mixture, as the arsenic may combine with the sodium or free alkali forming sodium arsenate and injury may result.

During the progress of applying these materials and watching results, the aphids continued to multiply throughout the field, and it soon became apparent that something must be done to check them, and done at once. Consequently all fields were sprayed from July 22 to 26. At this time, potatoes and tomatoes generally were threatened, and the demand for nicotine solution was so great that most retail dealers sold out their stock, and could not obtain more from the factory until too late to save the crops. Two or three dealers still had a small supply on hand but had raised the price, thus taking advantage of the situation.

We decided to spray with kerosene emulsion to kill aphids only and

demonstrate to the growers that they were not wholly dependent on nicotine solution. A common formula for kerosene emulsion and the one recommended on our spray calendar calls for one-half pound of soap and two gallons of kerosene to make thirty gallons. In this formula the soap seemed to be insufficient for the kerosene, so we increased the proportions somewhat. We also doubled the amounts of soap and kerosene but instead of making sixty gallons, diluted it less, to make fifty gallons, the right quantity to fill the spray barrel. Laundry soap was purchased by the box at wholesale prices, and the amounts of materials used were as follows:

Kerosene	4 gallons
Laundry soap (about 30 ounces)	3 cakes
Hot water	2 gallons

After churning, dilute to make fifty gallons. The soap was shaved into thin slices with a tool for shredding cabbages, and was dissolved in water on a stove set up in the field for this purpose. It was then mixed with the kerosene and churned back and forth through a small tube under pressure by means of a bucket pump with the hose directed back into the liquid, after which it was transferred into the pump barrel and sprayed upon the plants with hand-power barrel pump with spray rods bent at an angle of forty-five degrees near the nozzles.

This emulsion was effective, and all aphids hit by the spray were killed. A part of one field was sprayed with nicotine solution and soap for comparison. Some of the men who applied the mixture thought that slight injury was caused by the kerosene emulsion, but the same thing could be detected on some of the plants before they were sprayed. The variety was "Gold Coin," and there were many mosaic plants in the field; the tissues break down and the leaves turn brown earlier on these plants and this is probably the explanation of the injury rather than the spray.

A press notice was issued advising growers to spray at once with kerosene emulsion in order to save their crops, and to show them that they were not absolutely dependent upon nicotine solution. The comparative costs of the two mixtures are about as follows:

Kerosene Emulsion

4 gallons kerosene at .14 (retail)	\$.56
3 cakes soap at .06 (wholesale)	.18
Total	\$.74

Nicotine Solution

Nicotine sulphate ("Black Leaf 40") 1 pint (by the gallon)	\$1.31
Soap 3 cakes at .06 (wholesale)	.18
Total	\$1.49

Though the materials for the nicotine solution cost fully twice as much as for the kerosene emulsion, it required a little less work in preparation. The materials for kerosene emulsion could be obtained from any grocer in city or country, but nicotine solution was difficult to obtain promptly, and had become scarce in Connecticut on account of the unusual demand for it.

Mr. T. H. Parks: I would like to ask Dr. Britton if he had any visible burning or ill effects from combining nicotine sulphate with arsenate of lead and soap.

Mr. W. E. Britton: We didn't dare try it on a large field. We tried it on a few rows and saw some injury, though very slight. Of course the field had been sprayed previously with arsenate of lead, even where we used the nicotine solution and soap to kill aphids only.

Mr. J. S. Houser: We had one group of growers in eastern Ohio, who thought that the melting of the soap was too much bother, and they used washing powder, in combination with the nicotine sulphate and got results comparable to those obtained from the use of nicotine sulphate and laundry soap chipped and dissolved. I would like to ask if any of the entomologists here had experience of that kind; it facilitates the operation wonderfully because you don't have to bother with the fire and dissolving your soap if you use common washing powder.

Mr. W. A. Riley: It seems to me that in the work of Mr. Moore, Mr. Graham and Mr. Marcovitch, which was interrupted by the war, but the preliminary results of which were published in the *Journal of Agricultural Research*, they show that you might as well use the powder as soap. In other words the washing powder just as the soaps and various kerosenes used are likely to give good results, but the essential parts of their work was to show that the variation in kerosenes on the market was so astonishing that the variations and results obtainable from the sprays from the kerosene emulsions could be accounted for in many cases by these variations in the composition of the kerosenes that were available on the market, and likewise that the soaps differed enough to give astonishingly different results, depending upon the soap that was used.

For an illustration, in one of the common formulæ published, there is the recommendation of using ivory soap. Without knowing the details of Mr. Moore's work sufficiently to point it out, he found that this was not only useless, but nullified the effect of the particular spray that it was recommended in. And so it is perfectly clear from his results that in order to know what to recommend in the way of these

different compositions, we must standardize the ingredients, and that it will be perfectly easy for some of the big oil companies to put out a standardized kerosene, meeting best the requirements that are needed for this particular work.

Mr. C. R. Crosby: I would like to ask Dr. Britton what results he got from using blackleaf with the Bordeaux.

Mr. W. E. Britton: We couldn't see that it sprayed much better than the blackleaf and water alone. Of course that can be modified somewhat by using greater pressure in the pump. We had a hand outfit. I suppose the pressure was between 75 and 100 pounds.

Mr. W. H. Goodwin: May I ask what make of pump you used?

Mr. W. E. Britton: I think the pump was one of the Hardie pumps, using two lines of hose. We used the "Friend" disk nozzle with rather small hole.

Mr. W. H. Goodwin: The reason I ask this question is that different makes of nozzles and pumps give vastly different results. Spray solution may be effective or ineffective due largely to the force with which it is applied, its fineness, and the liberality in the quantities of spray used. An apparent excess per acre usually more than pays in the results obtained. Nozzles throwing a hollow cone spray require considerable care in handling them in order to get every bit of foliage sprayed covered evenly and forcefully with spray.

Mr. W. E. Britton: The same outfit was used in spraying with the nicotine solution, the arsenate of lead and the Bordeaux, and also in the nicotine solution with soap.

Mr. W. H. Goodwin: In some of my experiments I have found I can apply a much weaker spray solution by applying more spray per acre, and produce satisfactory results, provided I apply enough force behind the spray to get a thorough cover.

Mr. T. J. Headlee: The Kentucky Tobacco Products Company, the makers of "Black-Leaf 40," recommend for aphis a mixture composed of 1 part of the "Black-Leaf 40" to 1,000 parts of water with the addition of two or more pounds of soap to each 50 gallons. Even when applied with an engine-driven potato sprayer this formula has been with us an absolute failure. In spite of these facts, however, the company has until recently persisted in the recommendation. I am making these statements in the hope that Mr. Safro will explain the action of the company.

Mr. Safro: Before discussing this matter I would like to go back to Professor Houser's question, which did not seem to be answered as I thought it would be. His question was in regard to the use of washing powder as a spreader. Before going further, I want to make this state-

ment: for the last fifteen months I have not been in touch with entomological progress; if, therefore, something has developed within that time that is new, I am not acquainted with it.

A main function of soap is as a carrier. The alkali itself, or a washing powder will do admirably as a softener provided it is strong enough to function properly and not strong enough to hurt the plant. That is the reason we use soap—because of the wider margin of safety. The composition of soap is so uncertain that it must have a very wide margin of safety. You may use more than is necessary to function properly, and yet not injure the plant. The idea of using the soap is to use something that you can vary in amount, because there are no two soaps that are really so definite in composition that you can accurately say, "Use so many ounces."

Of course, in effect, we do say that; but it is not accurate. We have powders that are excellent spreaders, but it would be necessary to recommend a certain powder in one locality and another brand in another place. The brand would have to differ with the character of the water used.

Our biggest problem has been that of water as a spray-carrier. It is suggested that some entomologists could profitably specialize on waters, hard and soft waters. We have had to contend with waters in Arizona and Southern California, in parts of Colorado, in Idaho, and in the Northwest generally that were almost unbelievably hard.

Washing soda will be effective as a softener if it is used accurately for the particular water employed; but such accuracy is often not practical and the reason for preferring soap instead is to employ a substance that is comparatively safe.

An entomologist made a statement the other day which all of us should bear in mind. He said that he is working on the economic entomological problems of the farmer from the standpoint of the farmer—and this is a standpoint that certainly does deserve a great deal of consideration. Dr. Felt this morning stated that as entomologists we are independent. I sometimes fear we tend to be too independent. We do not coöperate sufficiently. Too often we work along, entirely forgetting the farmer's attitude—the item of labor, the item of mechanics, other items that a farmer thinks of, and that entomologists sometimes forget.

Those of you who have soap factories in your states should bear in mind that within short distances of the factories you can distribute and use, what the soap factory people call, I believe, the first boiling; it is really a soft soap, and is much cheaper than the finished product. All the boiling beyond that point merely puts the soap into condition that causes more trouble for the farmer in restoring it to its former liquid

condition. In southern California we used cottonseed oil soap, that is the first boiling.

The human nature of this whole problem from the farmer's standpoint is the fact that if he can avoid actually having to mix something, weigh something or measure something, he is going to get out of it regardless of a lot of other factors. Tell a man to cook something that may take only five minutes of his time and if he can get out of that by doing something easier, even if the other thing may not be as effective, it is human nature for him to do the other thing. You and I do it. We can all shine our own shoes, but generally we get somebody else to do it, and pay for the work.

I have sometimes wished that somebody would write an article on commercial recommendations and their bearing on biological recommendations. I think that, perhaps, would solve the problem. Very often in the laboratory something will happen that out in the field will not, and I think the difference of opinion regarding dilutions comes under that heading. In other words, a certain nicotine content will kill the pest, say, aphis, if that aphis is thoroughly covered with it. Now, then, it becomes a problem, whether to be more thorough in your work or try to cover up the sins of negligence by increased strength. I mean the sins of negligence on the part of the grower.

I wish some of those that have had experience within the past year would tell the grower to do the work thoroughly or try to cover it up by using a stronger dilution. I understand that in actual tests Professor Headlee found that a dilution of Black Leaf 40 of one to eight hundred would kill aphis in the laboratory. It seems to be thoroughness versus strength and you and I as thinking men are going to differ on some items. Here is a chance for each man to decide what he is going to do, to choose thoroughness or by increased strength to hide the lack of it.

In additional discussion of the soap problem: it has generally been understood that arsenates and soaps should not be mixed. The reason is that in some places many of us have actually seen cases of injury. Now it is the one case of injury that establishes the rule; it is not the thousand cases of no injury.

The more recent development I know only from conversation with several entomologists,—and that is, that such a combination is now considered safe. That is all I know about it. It is on good authority. It may be that the arsenates have been standardized better than they were before. But up to fifteen months ago the status was that though there is only one chance in a hundred that there will be any injury following such a combination, because of that one chance, we have always been advised not to use it. However, that is superseded by the later announcement that arsenates and soaps can be mixed.

Mr. W. E. Britton: I understand that the nicotine solution with soap and lead arsenate has been used in Massachusetts and has been recommended there; that while there may be occasional injuries, it isn't necessary to take it into consideration as compared with the injury done by the aphis.

I wish to say one word in regard to the question of the supply of nicotine solution. I am told by a man representing the Kentucky Tobacco Products Company, that they have arranged to have a supply in each state, so that the situation that I mentioned as occurring in Connecticut will probably not occur again.

Mr. Safro made one statement; he said the use of soap is for the purpose of obtaining the alkali. It is necessary to have some grease with it. That is, you would not recommend household lye in connection with nicotine alone, would you?

Mr. V. I. Safro: I wouldn't recommend it, but it will do if it is used accurately. An entomologist can use household lye. In the northwest, where some of the growers are as careful and as painstaking as we are, they can use lye safely, but you certainly wouldn't recommend it to a grower, under the penalty of being forever discredited.

Mr. T. H. Parks: I am particularly interested in Dr. Britton's talk because what I am after is to get the farmers to put on this spray and not get scared at the expense, and that is what they did in Ohio last year. If we can safely use kerosene emulsion as a substitute for tobacco sprays we shall have more people spraying to solve the potato aphis problem.

Last year I noticed that many would apply one spray and then if they did not get results they would quit. I had read Professor William Moore's article in the June number of the Journal. He combined oleic acid (red oil) with a 40 per cent nicotine solution which made the tobacco spray cheaper. I tested this in the field according to Professor Moore's formula, though we were able to purchase only a few ounces of oleic acid. When this spray (nicotine oleate) was applied as strong as 1 part to 500 of water, it did the work as well as Black-Leaf 40 (1–500) plus soap (2 pounds). Weaker strengths of nicotine oleate were not satisfactory. I figured out the difference in the cost and it was favorable for the new spray. I then got in touch with one of our commercial insecticide companies and obtained the wholesale price of oleic acid f. o. b. New York.

Later in spraying for turnip aphis we experimented with Black-Leaf 40 and soap at various strengths in comparison with this Black-Leaf 40 and oleic acid combination at different strengths. Here it was found that Black-Leaf 40 (1–800) and soap (2 pounds) when used thoroughly did the work and did it well. The weakest nicotine oleate

strength that was effective was again found to be 1–500. When I figured the expense of these two combinations there was such a little difference in favor of the new mixture that I gave up the idea of trying to get our farmers to use it.

Now I am going to emphasize thoroughness first, and sprays no stronger than known to be satisfactory if they are applied thoroughly. If we can trust kerosene emulsion in the hands of farmers it will help solve the cost of repeated spraying to control potato aphis.

Mr. E. N. Cory: I want to give our experience in regard to the strength of Black-Leaf 40 that is required. Where we supervised work we were able to get results with Black-Leaf 40 at the rate of 1 part to 800 parts of water, but the farmers did not get results by using this strength. They doubled the amount of Black-Leaf 40 and in many cases secured excellent results. To them it was simply a problem of getting control, rather than a matter of cost, as they were growing tomatoes under contract and the price was excellent. Many of them stated it was not a question of the cost of the insecticide, but a question of killing the lice.

I would like to ask in regard to the effect last year of parasites and lady-beetles in destroying aphids. We found that toward the end of the infestation, or in fact at the height of infestation, the lady-beetles were doing excellent work and this was a question in the mind of many farmers as to whether parasites were not effective in control rather than spraying.

Mr. C. P. Gillette: I have done a good deal of work in controlling plant lice in Colorado, and have found that if the application does not kill, it is because the body of the aphid is not thoroughly wet with the insecticide. I once gave a student some Black-Leaf 40 for use in killing the black chrysanthemum aphids in the greenhouse. He reported that he could not kill them with any strength that he used. I made a test and found that I could not kill this aphid, but if soap was added to the water good results were secured. If it was not used very little of the spray would remain on the bodies of the aphids. One part of Black-Leaf 40 to 1,000 parts of water is sufficient to kill them, if their bodies are thoroughly wet.

Mr. T. J. Headlee: Our experience with vegetable plant lice during the past season has raised the following questions: (1) Is it possible in all the species attacking vegetables to discover the infestation while the plants are yet small before they have had a chance to assume a recumbent habit and by a single thorough treatment of any of these crops bring the aphis under control? (2) What sort of apparatus must be used, what sort of formula, what pressure and how many gallons must be used on an acre?

Mr. L. B. Smith: In eastern Virginia we have viviparous females occurring throughout the year. Our most serious outbreaks of the green peach aphis occur during the winter. At certain times they will be scarce, then, as Dr. Headlee described, the aphids will appear in enormous numbers. The thirty-first of October of this year was particularly warm; the air was filled with winged forms of the pink and green aphid which were apparently migrating from weeds and kale to young spinach plants. The spinach became heavily infested and the outbreak was so serious that by November 25, several shipments were seized by the health authorities in New York City. The yield was also cut severely. At the present time, as a result of the outbreak of aphids, there is occurring an epidemic of the disease known as spinach blight. I believe the southern conditions influencing the development of aphids are quite different from those further north where the sexual forms are produced. If the conditions which cause the outbreaks can be foreseen and the control measures applied in time, it will undoubtedly save in a great measure some of the losses which now occur.

We have recently perfected a means of spraying young spinach plants. Spinach is a low-growing plant and is difficult to spray effectively. By using a gasoline outfit and maintaining sufficient pressure, we have been able to get very good control of the aphids this fall. I might also say that in spraying for the control of the green pea aphid, the pink and green aphid of potato and the green peach aphis, our results have been similar to Dr. Headlee's, we have had to use strong solutions. With the most careful spraying it is impossible to soak every aphid on a plant, particularly spinach or potatoes, when the leaves are savoyed or curled, with any arrangement of nozzle that we have been using. By having a solution with the proper wetting power, so that when the spray strikes the aphid it will form in a film, good results can be obtained by using the stronger solution. Under field conditions, on the crops mentioned, we have not had good results with Black-Leaf 40 diluted more than one to six-fifty, unless excess quantities of soap are added.

Mr. P. J. Parrott: The entomologists in New York, during the last fifteen or twenty years, have been called upon at different times to carry on some very extensive work against sucking insects, such as the apple red bugs, the pear psylla and several species of plant lice, particularly those attacking apple trees and cabbage. What spray to recommend to a farmer is oftentimes a puzzling question, because in addition to effectiveness, one must also consider economy and safety. It is the general opinion of the entomologists of New York that the great merit of the nicotine spray is its safeness. Before the nicotine

sulphate was introduced we used to have to rely on soaps and kerosene emulsion, and I recall very distinctly that a lot of damage was done to cabbages and fruit trees by kerosene emulsion. Later, when the oil sprays were abandoned in favor of soap, we were then confronted with this fact: that soaps varied tremendously in their important constituents. Our chemists showed that the water content varied from 8 to 60 per cent and, on account of the variation in soap, we were forced, in spite of the cost of nicotine sulphate, to recommend it.

The experiences that have been related in regard to aphids show the great need of thorough-going studies of the life-histories and habits of the various species and business experiments to develop methods of control that are economical and efficient. As regards the strength of the nicotine sulphate, we generally recommend one part to a thousand parts of water, and rarely one to eight hundred. In considering dilution, I would also emphasize the importance of timeliness and thoroughness of the treatment.

Mr. W. C. O'Kane: I would like to ask the gentleman, what are you recommending for the spraying of apple foliage where you need to use a stomach poison as an early spray, either the pink spray or the calyx spray, and at the same time have a big infestation of aphids coming on?

Mr. P. J. Parrott: My answer to your question is that if farmers were following my instructions they would not find it necessary to use soap in the pink spray. We are working on the proposition that they should make a delayed dormant application. Of course I realize that various workers differ on that point, but we have carried on experiments on eight and a half acres in Geneva now for the last five years and we have had no difficulty whatsoever in securing an almost complete killing of the different species of apple lice.

Mr. W. C. O'Kane: How late were you delaying your application for that purpose?

Mr. P. J. Parrott: Until the leaves of the advanced buds are about one quarter to a half inch.

Mr. W. H. Goodwin: The single variety of apples?

Mr. P. J. Parrott: Our work on Station grounds has been entirely with Rome apples, but there is considerable experimental data to show that in blocks of solid varieties, like Greenings or Baldwins, which constitute 60 to 70 per cent of the apples grown in New York, the same results can be obtained; that is, the grower can obtain commercial control of the insect.

Mr. T. J. Headlee: Our experience on the point raised by O'Kane is that it does not make any difference whether the eggs of the apple aphis have hatched or not, because at the green bud stage the

outer covering of the egg has split and the egg has become very susceptible to destruction by the delayed winter-strength lime-sulphur and nicotine treatment. Our experience of the past three years shows that the eggs of the rosy apple aphis and of the green apple aphis have not all hatched by the time the green bud stage has been reached. We endorse the recommendation of Professor Parrott that the trees be thoroughly sprayed at the green bud stage with a mixture composed of winter-strength lime-sulphur and nicotine because the eggs which have not yet hatched are at that time in a very susceptible condition. We do not agree, however, with Professor Parrott in that the nicotine should be used at the rate of 1 to 1,000, but have been compelled, by the evidence of three years' experience, to advise adding 40 per cent nicotine to winter-strength lime-sulphur at the rate of 1 to 500. It may be that the difference between our experience and that of Professor Parrott is due to ecological difference, incident to the difference in geography.

Mr. P. J. Parrott: Do you use that one to eight?

Mr. T. J. Headlee: We used 1 part of the commercial lime-sulphur to 9 parts of water and added to it 40 per cent nicotine at the rate of 1 to 500.

Mr. C. P. Gillette: The peach aphis hatches very early in the season. It is not uncommon to find mothers giving birth to the young by the time the buds are open. They can be killed on any of the pit fruits such as peach, plum or cherry by an early spray. The false cabbage aphis is in Colorado an inhabitant of Cruciferous plants. The peach aphis is the most general feeder that we have as it feeds on something like 75 host plants.

Adjournment.

Morning Session, Friday, December 27, 1918, 10.35 a. m.

The association met in joint session with the Section on Horticultural Inspection. Mr. E. C. Cotton, Chairman of the Section, presided.

Vice-President E. C. Cotton: As I have not prepared an address for this occasion, we will listen to the papers listed on the program. The following paper will be read by Mr. E. N. Cory, on "The Status of the Oriental Peach Moth."

THE STATUS OF THE ORIENTAL PEACH MOTH [1]

By E. N. Cory, *College Park, Md.*

Grave apprehensions were entertained in the last few years as to the damage which might result from the establishment of *Laspeyresia*

[1] Contribution from the Maryland State College of Agriculture.

molesta in several of the states on the Eastern Seaboard. Judging by our first information in regard to the pest, these fears were well founded. The fruit-feeding habit seemed most serious and the progress of the infestation has been carefully watched and further dissemination guarded against in some instances.

After three years' observation and investigation certain facts have come to light that lead to the belief that the pest may finally come to have approximately the same destructive status for peach as the codling-moth has at present for the apple in well-cared-for eastern orchards. At most, its destructive force should be no greater.

This estimate is based principally upon the counts made at College Park by Dr. Garman of the infested fruits and in part on the comparative growth of infested and non-infested trees.

In the face of a long standing infestation which would be rated as of considerable severity, the fruit from the following varieties showed the percentages of infestation to be quite small. Except in three cases, the per cent of infested fruits did not amount to over 5 per cent. Champion with 12 per cent infested fruit, Lyon with 13 per cent and another late variety with 35 per cent were the exceptions. The average infestation on Greensboro, Carmen, Champion, Elberta, Late Crawford, Mountain Rose, Lyon and the unknown variety was 4.3 per cent based on actual counts of over 4,000 peaches.

It may be possible to reduce this fruit infestation even more. Spraying experiments show that the dry particles of self-boiled lime sulfur will kill newly hatched larvæ that attempt to crawl through them. Dusting, therefore, may give greater control than spraying.

The comparative growth of infested and non-infested twigs on bearing trees shows only a slight advantage to the infested tree. Careful measurements show that the average growth of infested twigs for the season was 11.1 and for the non-infested twigs 8.8 inches. The difference in this case of only 2.3 inches is hardly worthy of serious consideration.

Another factor that may have a very considerable influence on the potential destructiveness of the insect is that of parasitism. Eight parasites, one of the egg and the balance of larva and pupa, during the past season contributed to the control of the pest. Approximately 60 per cent of the eggs were parasitized by *Trichogramma minuta* Riley. About 50 per cent of the larvæ and pupæ were also parasitized. This leaves a possible one fifth of the normal brood as survivors. The egg parasitism in 1917 was 80 per cent; so that it seems fair to assume that a high percentage of parasitism may reasonably be expected, particularly since *Trichogramma* is a general feeder. Five of the parasites were Hymenoptera and three Diptera.

Control experiments are quite variable in their results. The question of how much arsenical spray a peach tree will stand as well as the actual value of its application is involved.

The effect of various insecticides on the egg is interesting. Nicotine sulfate at 1–500 or 1–800 alone gives about 70 per cent mortality and in combination with self-boiled lime sulfur, arsenate of lime and lime caseinate is equally as effective in laboratory tests. Field tests show that even better results may be obtained. In one instance only three infested twigs were found on a sprayed tree while thirty were taken from a tree of the same size along side of the sprayed tree. Apparently the timely application of the proper insecticide will control the pest but the question of economy in spraying and the possible results to the tree will bear close scrutiny.

One of the most serious points to be considered is the feeding in apples by the late broods. Apparently this is one of the greatest sources for over wintering forms, at least in young trees adjacent to apple orchards.

The confining of the pest to its present limits seems to be scarcely possible owing to the fact that infested fruit serves as the greatest potential source of dissemination. Measures of quarantine that disregard fruit are not likely to be successful in checking the spread of the pest. Nursery stock usually has smooth bark and probably is seldom used for pupation. Pupation is more likely to occur in the ground than on smooth bark trees.

In view of the facts set forth, it would seem that unless unforseen circumstances alter the present habits of the pest, that it is little to be feared. The insect should be considered in the same light that we consider the codling-moth as far as the orchard is concerned and in nurseries it should be treated as any other nursery pest. That is to say that every precaution of inspection should be utilized to prevent its dissemination on the stocks.

Vice-President E. C. Cotton: This is one of our new pests and I trust this paper will be thoroughly discussed.

Mr. P. J. Parrott: I am wondering if there are any of the Federal workers here who can report what they found in their effort to determine the destruction of the species. One agent visited Geneva, N. Y., and spent a number of days inspecting nurseries and orchards in that vicinity. He then visited Rochester and Buffalo, but I haven't heard as to the results of the examinations that were made.

Mr. W. B. Wood: I do not have the records here, but as I remember it, I think I can give you practically the way the inspection results

stand. The inspections were made throughout most of the states. There were a few that we were not able to touch. In the eastern states the pest was found in the vicinity of Washington, both in Maryland and Virginia, and in the vicinity of Baltimore. It was found in southern Pennsylvania, east of the middle of the state; it was found in New Jersey, in the southern end of New York state; it was found on Long Island, and at one point in Connecticut. Outside of these localities the insect was not found. It was not found in northern or western New York, although we found there what we term "typical injury." This same type of injury was found in a great many other places that were inspected, but I believe that the injury is caused by *Anarsia lineatella* in these cases.

This insect injures the trees in exactly the same manner, and we feel that we are unable to tell from the injury which insect causes the trouble. The results of the inspection that we have made were based altogether on the insects that were collected. In no place did we report the insect as being found where it was not collected but where typical injury was present. It may be established in other localities that were missed, but as far as we know, this was the general result—the insect being present only in a few of the states along the eastern seaboard, from Connecticut south to Virginia, a short way south of Washington.

Vice-President E. C. Cotton: The fact that the insect was not found, of course, was no proof that it does not occur there, because as I understand it, the surveys were made in a general manner rather than in a thorough manner.

Mr. W. B. Wood: The surveys were made in most cases very generally, and the insect could very well be missed.

Mr. S. M. Frost: I would like to ask if the injury might not be due to the tarnished plant bug on peach, or could it not be attributed to a Lepidopterous insect?

Mr. W. B. Wood: In the case of the boring of the Lepidopterous insect, *Laspeyresia molesta*, the twigs are, I think, always hollowed out on the inside; with the injury from the plant bug I don't believe this would be the case. I have often noticed injury that was attributed to the plant bug, and it was quite different from that caused by *molesta*, the twigs always being hollowed out by the latter insect.

Vice-President E. C. Cotton: The next title is "Control Work Against the Japanese Beetle," by W. H. Goodwin.

CONTROL WORK AGAINST THE JAPANESE BEETLE

By W. H. Goodwin, *New Brunswick, N. J.*

(Withdrawn for publication elsewhere.)

Mr. W. H. Goodwin: The plans for the coming season are much larger. There is to be considerable increase in the equipment, and following somewhat of a similar plan as we have followed in the past season, including the addition of several trucks, and another tractor, and six or eight tanks for the treatment of the grubs with a solution of sodium cyanide. We have tried putting crystal cyanide in the ground, but as yet results have not been good. There is one other method that could be used in this problem and that is taking over something like fifteen thousand acres, and simply paying those farmers so much for their crop, and putting the entire thing under cultivation and keeping it absolutely polluted with poison where there are field crops. If we could actually take those farms over and keep them under cultivation throughout the season I think we could eradicate this pest within a year.

Vice-President E. C. Cotton: Does anyone wish to ask any questions or discuss this paper?

Mr. E. P. Felt: I would like to ask Mr. Goodwin whether it would not be cheaper in the long run to adopt the drastic measure which he suggested at the close of his remarks, and simply eliminate, within practical limits, all vegetation?

Mr. W. H. Goodwin: That would be much cheaper in the long run, but it means an initial outlay of possibly three or four hundred thousand dollars. That country produces some money; in that section they fertilize heavily and they crop with a succession of crops, which makes the total income from an acre very high, and they get top-notch prices in the market at either Philadelphia or New York.

Mr. E. R. Sasscer: I would like to ask Mr. Goodwin if the presence of that cyanide solution in the soil has any effect on the growth of the plant.

Mr. W. H. Goodwin: As far as we can tell, there is absolutely no effect and no injury where we use a solution of one ounce to fifteen gallons of water. We need that amount of water to penetrate, and lack of penetration seems to be the fault of drilling the cyanide into the ground. I don't believe we could use cyanide drilled in the ground except in the fall, and we haven't tested any method extensively excepting in the fall.

Mr. E. R. Sasscer: There is one other point in this paper that interested me, and that is in regard to the attraction of the beetle to the light. I remember when this insect was first discovered in New Jersey I had occasion to look up the literature on this beetle, and I was not very successful, but I found among the papers examined a short note on *Adoretus tenuimaculatus*, a related insect, which is now established in

Hawaii, and as I recall lights were placed around valuable plants at night to keep the insects away. It seems that the adults do not feed after midnight and the lights are then extinguished.

Mr. W. H. Goodwin: I won't vouch for this translation at all, but what is translated from the Japanese is that they were strongly attracted by lights, and that was one of the ways of catching the beetles. With us, trap lights were a complete failure. I have found beetles repeatedly within ten to twelve feet of lights that are only four feet above the ground, and they were not the least bit disturbed or attracted by the strong light.

Vice-President E. C. Cotton: I would like to ask Mr. Goodwin if he has tried other soil fumigants.

Mr. W. H. Goodwin: We used carbon bi-sulphide on azaleas, and got serious injury. That soil is sandy and loose, and makes it extremely difficult to get any satisfactory results with carbon bi-sulphide unless the soil is very wet.

Mr. J. G. Sanders: In the case of some of our closely allied American beetles, they fly long distances, and they quickly retire. I wonder if it is the same with the Japanese beetle.

Mr. W. H. Goodwin: You can occasionally follow them with field glasses. They seem to settle within a few hundred feet. They simply riddle flowers, hollyhocks, and things of that sort, and roses. They simply chew them up, in other words. They are such general feeders that it makes the problem much more complicated because they will feed on any plant, except grass and corn, and a few things like that. They bore into the ends of corn ears, going down around the silks, and there is where the danger comes in transporting them, when that corn is cut and carried into the markets.

Vice-President E. C. Cotton: The next paper is entitled, "The Discovery of the European Potato Wart Disease in Pennsylvania," by Mr. J. G. Sanders.

THE DISCOVERY OF EUROPEAN POTATO WART DISEASE IN PENNSYLVANIA

(Plate 3, figure 2.)

By J. G. Sanders, *Economic Zoölogist, Harrisburg, Pa.*

The discovery of the European potato wart disease [1] in Luzerne County, Pennsylvania, late in September, 1918, was a distinct surprise to all whose interest is concerned in such matters, although a constant watch has been maintained for the appearance of this dangerous pest within our borders for several years.

[1] *Chrysophlyctis endobiotica* Schilbersky. Described in 1896.

Greater interest must attach to the fact that this disease has been firmly established for at least eight years in an unusual situation, where it might have continued undetected for several years longer except for its almost accidental discovery.

Hidden away in the gardens of the small mining villages, where the consumption of potatoes much exceeds the production, the disease might have continued its advance for a few years to other localities similarly situated, without spreading to the larger potato-growing districts nearby, where eventually it would have appeared in our public markets, and attracted the attention of inspectors and the more enlightened growers.

Immediately following the discovery of the disease, the writer went to Washington and conferred with Dr. W. A. Orton of the Bureau of Plant Industry, to secure the assistance of trained men to aid in our survey, which must be hurriedly carried out because potato digging was already starting in the Hazleton district, which lies at an altitude varying from 1,600 to 2,000 feet elevation. Doctor Orton, keenly alive to the dangerous situation, sent several of his trained men, and called on several plant pathologists who had been engaged in the Federal plant disease survey, to aid in the work. Field men of the Pennsylvania Bureau of Zoölogy were called in as rapidly as possible, and in about six weeks, approximately three hundred mining villages, towns and cities were hastily surveyed by garden inspections. At the close of our season's work, a total of twenty-eight villages and towns were found infected in varying degrees, a few having only one, two or three gardens showing the disease.

The origin of this disease, and a few facts of its possibilities of dispersion will be of interest. The Federal Horticultural Board, as one of its first official acts, fixed on September 20, 1912, a quarantine on further entry of European potatoes to the United States; yet its power granted by Congress came too late to avert the entry of this disease, which we must now fight with all power and ability at our command, to safeguard our most important vegetable crop.

Inquiries from the villagers, mostly Slovaks and Polish and allied races, with a few Italians, determined the fact that most of their potatoes had been bought from the company stores of the coal mining companies, who in turn had purchased largely from the Hazleton Produce Company. Following this information, it was learned that considerable quantities, several carloads, of German potatoes had been bought and sold by them in 1911 and early 1912, and hence our evidence was sufficient. Our next problem was to determine as rapidly as possible the limits of the spread of the disease; and we felt, after a preliminary survey in which we found much disease, that it must also

be scattered throughout our larger anthracite coal mining area, covering a large area of northeastern Pennsylvania. It is a pleasing report that we can offer now, that no other centers of infection exist, as far as our present knowledge goes, although subsequent inspection may reveal it at other points.

The finding of this disease in such peculiar and unsuspected places will at once caution our inspectors to look for it in similar localities, where the demand for potatoes far exceeds the local production, and to which points foreign potatoes may have come to supply the demands in years of short crops. Especially important, it seems, is a careful inspection in gardens of our larger cities and their suburbs, and of larger manufacturing centers, which should be carried out next summer and autumn with as much care and speed as possible. Our eastern states should immediately secure special appropriations for such surveys, so that no time will be lost in rounding up the pest.

Originally described from Hungary by Professor Schilbersky in 1896, and first brought to public attention, the potato wart disease has rapidly spread through Hungary and Germany into the British Isles and Norway, and there is strong probability that under the war conditions for the past four years, the pest has been even more widely spread than our present records would indicate. Late reports from England show that tremendous spread of the disease has obtained on account of the lack of inspection facilities during the war period, and that the loss, in consequence, has been very heavy. The disease was introduced into Newfoundland, at the islands of Saints Pierre and Miquelon, but the Pennsylvania record is the first for the United States.

The wart disease belongs to one of the lower families of fungi, the *Olpidiaceæ*, and is closely allied to the *Synchytriums*—formerly having been classified in this group. Fortunately, the disease is known to attack but one plant other than the common potato, *Solanum tuberosum*, and its varieties; and even tomato plants growing in very badly diseased soil in the Pennsylvania infections, showed no trace of the attack of the potato wart disease. Bitter-sweet is slightly affected.

Numerous publications and references to this dangerous disease have appeared in European literature, but up to the present little has appeared in American literature. Circular No. 52 of the Bureau of Plant Industry, by W. A. Orton and Ethel C. Field, discusses briefly the wart disease of the potato, its nature and distribution, along with three excellent halftones, as well as a list of the more important literature pertaining to this disease published since 1896.

All portions of the potato plant may be attacked by this pest, but more frequently it is apparent on the underground portions of the stem, roots and tubers. It attacks the tuber usually at or near the

1. *Lecanium prunastri* Fonsc. The globular fruit scale on plum twig.
2. *Chrysophlyctis endobiotica* Schilb. European wart disease of potatoes from Europe, established about Hazleton, Luzerne Co., Pa.

"eye," and there rapidly develops a very distinct, warty growth, usually brownish in color. These warty growths enlarge rapidly, and ultimately cover and transform the entire potato to a warty mass, somewhat resembling a piece of cauliflower head. This stage having been reached, the warty mass decays in the ground, thereby releasing myriads of thick, heavy walled spores, which remain viable in the soil, according to experiments carried on in Europe, for more than six years —even in the absence of potato growth. In other words, the disease has appeared after a six-year rotation of crops other than potatoes, and has attacked potatoes planted the following season. No definite records are available regarding the exact longevity of the spores in the soil, though it is highly probable that a ten-year period must elapse before infected soil can be considered absolutely safe for potato planting.

The disease can be transferred to clean soil in several ways, most important of which are through infected seed potatoes, infected parings, spring freshets carrying infected soil to new localities, the removal and transfer of root crops from infected gardens to new localities, and still another very important and unsuspected method is that of its possible transmission by manure from animals, which have been fed on uncooked potatoes infected with this disease. It will be seen, therefore, that the control measures which must necessarily be adopted in dealing with this pest are somewhat varied, and will require no inconsiderable attention to details, combined with the necessary legal power and authority.

It is proposed to quarantine the entire affected area, including the few outlying infections, from which quarantined area we will prohibit the removal of potatoes, root crops, manure and any materials which might carry the disease. Within the quarantined area certain "restricted" areas will be designated, within which the growing of potatoes will be prohibited. In order to further supervise the inspection for the disease in future years, it seems desirable to permit the growing of potatoes within the quarantined area only by license furnished from the Pennsylvania Department of Agriculture.

It is now contemplated that a laboratory for the more careful study of this disease will be established—probably at Freeland—and in addition to studies of the rapidity of dissemination, the life-history and etiology of the disease, certain experiments will be carried on, using steam sterilizing methods in an effort to kill the spores in the soil. This treatment, if successful, will be particularly valuable, even though somewhat expensive, in outlying infections where only small areas need treatment.

I wish to express my sincere thanks and appreciation for the assist-

ance furnished our survey by the men associated with the Bureau of Plant Industry, and workers in other states, who came to our assistance on very short notice. It is our purpose and desire to exert the utmost effort in every way possible to prevent the further spread of this most serious known potato disease, and considering the rather favorable conditions under which the disease occurs (in isolated villages without intervening cultivated territory) we have reason to believe that we can ultimately eradicate the pest. No expense and effort is too great, in consideration of the extremely dangerous and destructive nature of this long-lived soil-infecting plant disease, coupled with the fact that it is threatening the most important vegetable food crop in our United States.

AN EUROPEAN SCALE INSECT BECOMING A MENACE IN PENNSYLVANIA

By J. G. Sanders, *Economic Zoölogist, Harrisburg, Pa.*

It seems desirable to call the attention of our entomologists and horticultural inspectors to a scale insect, probably a native of China, later introduced to Europe, which in recent years has become established in Pennsylvania. This soft scale insect, *Lecanium prunastri* Fonsc., has been recorded a number of times from various places in Central Pennsylvania at rather widely scattered points, but principally from the south central and warmer section of the state.

Its principal host plants are peach, sweet cherry and apricot, and within the past two or three years this pest has become sufficiently abundant in a few localities to cause genuine damage and alarm to the fruit growers. Some branches of peach become so thickly covered with the scale, that they are badly dwarfed, and ultimately killed. However, in the orchards where the customary winter dormant spray with lime-sulfur wash is practiced, the scale has not assumed dangerous proportions.

In general appearance, in the summer season, it is not dissimilar from the common terrapin scale, although on closer inspection, it will be seen that the adult female scales are almost globular in form, and usually deep, chestnut red colored, usually closely massed on a tree when abundant. Not infrequently a large number of the small, glassy white male scales are associated with the larger round female scales. The accompanying figures will show some of the principal distinguishing characteristics of this scale, in comparison with our other common Lecaniums (Pl. 3, fig. 1.)

As far as records of the United States Bureau of Entomology indicate, the scale has never been reported except from the State of

Pennsylvania. Fortunately, it does not occur in close proximity to our larger fruit tree nurseries, hence has not become a nursery pest problem.

Records of *Lecanium prunastri* are at hand from the United States Bureau, which indicate its having been collected by F. N. Meyer in 1907, at several points in China, and also in Chili Province, China, in December, 1916. It was interesting to note that on a sample of plum from Dougsi, China, it was associated with *Diaspis pentagona*, the later species having also been found on various hosts quite commonly at several points in China. The writer can furnish a limited number of specimens of this scale to those desiring them, and will also gladly identify any material which is under suspicion as this species.

Mr. T. B. Symons: I would like to ask if there is any attempt being made to grow different varieties in infested areas for immunity tests, as I understand that is the means of combating this disease in England.

Mr. J. G. Sanders: As I understand, they now have two or three varieties in England which are absolutely immune. It has been determined in conducting our laboratory experiments up there next year to test out all well-known varieties of potatoes we have in this country with a view to determining resistance and immunity. In the areas now infected we will absolutely prohibit the growing of potatoes with the idea of extermination of the disease.

I might say another word here, that the potatoes, after assuming that entire warty condition, quickly decay in the soil so that it impedes inspection work considerably if one is not on the ground at the proper time.

Vice-President E. C. Cotton: That would mean then the inspection would have to be made within three weeks after blooming.

Mr. J. G. Sanders: From that time on until digging is done. Our idea is to permit the growing of potatoes only by license; we shall have men on the ground to control it in that way.

Mr. C. H. Hadley, Jr.: Do you find that disease is transmitted through storage?

Mr. J. G. Sanders: There are many points that I might mention about this disease that I could not bring out on account of lack of time. Potatoes affected by this disease cannot be held in storage, because they will quickly decay.

Vice-President E. C. Cotton: The spores from the decaying warts might attach themselves to sound potatoes and be a source of infection of soil in the field.

Mr. J. G. Sanders: Yes, and it would also be dangerous to transport the potatoes.

VICE-PRESIDENT E. C. COTTON: If there is no further discussion, we will take up, "The European Corn Borer Problem," by D. J. Caffery, Melrose Highlands, Mass.

THE EUROPEAN CORN BORER PROBLEM[1]

By D. J. CAFFREY, *Scientific Assistant, Cereal and Forage Insect Investigation, Bureau of Entomology, United States Department of Agriculture*

INTRODUCTORY

During the month of July, 1917, the presence of the European Corn Borer (*Pyrausta nubilalis* Hubn.) was discovered in the vicinity of Boston, Massachusetts by Mr. S. C. Vinal of the Massachusetts Agricultural Experiment Station. A report of this discovery, and of the preliminary investigation was published by Mr. Vinal in December, 1917[2]. At that time the insect was found to be present in an area of approximately 100 square miles immediately north and northeast of the city of Boston and was causing severe damage to sweet corn and other plants within that area.

The towns located at the mouth of the Mystic River were more generally infested than the others and from this it was inferred that the pest first became established in that vicinity. Considerable quantities of raw hemp are annually imported from Europe for use in the cordage factories located along the Mystic River. As hemp is one of the favorite food plants of the insect in Europe this may have been the medium through which the European Corn Borer was introduced into this country, although other plants may have acted as the carrier.

The seriousness of the situation caused by the presence of this insect and its potential menace to the corn crop of the entire country was early realized. The problem therefore became one of national importance and plans were made for a coöperative investigation of the subject during the season of 1918 by the Massachusetts Agricultural Experiment Station and the Bureau of Entomology, Division of Cereal and Forage Insects.

From the facts learned to date concerning the habits, food plants and distribution of the insect it is believed that the European Corn Borer is one of the most serious plant pests that has yet been introduced into the United States.

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[1] Published by permission of the Secretary of Agriculture.

[2] Vinal, S. C., Mass. Agri. Experiment Sta., Bull. 178.

Serious Nature of this Imported Pest

Foreign History

Foreign literature records the fact that the species is widely distributed in Central and Southern Europe, West Central and Northern Asia, China and Japan. Corn, hemp, hops and millet are the principal economic plants attacked by the pest in the old world and a loss of 50 per cent of the crops frequently results from its depredations.

History in Massachusetts

Prior to 1917 the European Corn Borer had never been reported from the United States. During the period from its discovery in July, 1917, to November 30, 1918, the species was found to be present in thirty-four towns of Eastern Massachusetts comprising an area of about 320 square miles immediately west, north and northeast of the city of Boston. Adjacent areas in Massachusetts, Rhode Island, Connecticut, New Hampshire and Maine were examined for the presence of the insect, but with negative results.

Food Plants

The principal food plants of the species in Massachusetts were found to be sweet corn, field corn, fodder corn, celery, beans, potatoes, Swiss chard, beets, spinach, dahlias, gladiolus, chrysanthemums and several species of the larger weeds and grasses. Although corn is the favorite and preferred food plant, the great variety of other host plants has allowed the species to become established in almost every locality throughout the infested area. This greatly complicates the problem of controlling the pest in the area where it is now present and of preventing its further spread.

Habits and Life-History

The European Corn Borer passes the winter as full-grown, or nearly full-grown, larvæ within their tunnels in the host plant. They resume feeding with the advent of warm weather in April or May and pupate about the middle of May within their larval tunnels. The moths emerge about the first week of June and the females deposit their eggs, generally on the lower surface of the foliage of the host plant. The eggs are deposited in masses of from five to fifty eggs, individual females depositing an average of 350 eggs. The habits of the resulting larvæ vary according to the species of plant attacked. In the instance of corn the newly hatched larvæ feed first upon the epidermis of the leaf blades and then enter the stalk and tunnel through all parts of the plant except the fibrous roots. This results in a general weakening of the

plant which retards the development of the ear and in many cases prevents proper fertilization through injury to the tassel. The ears are also tunnelled by the larvæ which enter by way of the pedicel or bore directly through the husk and tunnel through the kernels and cob. As many as fifteen full-grown larvæ, each about an inch long, have been found feeding upon and within a single ear of sweet corn. This damage to the stalk and ears by the insect is often still further increased by the ingress of various rots which reduce both stalks and ears to a soft, putrid condition totally unfit for use as seed or for feeding to stock. Actual field counts in a quarter-acre plot of sweet corn have resulted in finding that 100 per cent of the ears were infested by larvæ of the European Corn Borer. Field counts made in badly infested areas showed an average of 46 larvæ per plant; or at the rate of about 1,050,000 per acre.

The larvæ of this generation reach full growth and pupate within their host plant about the middle of July. The moths emerge about the last week of July and deposit eggs for the second generation of larvæ on late corn or upon other wild or cultivated plants. The habits of these second generation larvæ in late corn are essentially the same as for the first generation except that greater injury is sustained by the ears. The larvæ feed until their activities are halted by the advent of severe winter weather in November or December.

It will be noted then that there are two complete generations of the European Corn Borer each year and that individual females in each generation deposit an average of from 350 to 550 eggs each. This enables the insect to increase its numbers very rapidly as its multiplication is practically unchecked by the activities of parasites or other natural enemies.

Danger of Widespread Injury to the Corn Crop

Although the female of the European Corn Borer is capable of flight and may gradually extend the limits of infestation by natural spread, the chief element of danger in this respect is that infested plants or plant products may be transported from the area now infested by the insect to points outside of that area.

Danger of Spread Through Transportation of Corn or Its Products

The transportation of corn or its products offers perhaps the most common means by which the insect may become widely disseminated.

Sweet Corn or Roasting Ears. During the early summer season considerable quantities of sweet corn are shipped north from the Boston wholesale market in order to take advantage of the early season prices prevailing in northern Massachusetts, New Hampshire and

Maine. Much of the sweet corn originates within the area infested by the European Corn Borer. An examination of the sweet corn exposed in the Boston wholesale market at this time revealed the fact that many of the ears and the attached portion of the pedicel contained larvæ and pupæ of the pest. Similar lots of corn had been sold to retailers through this same medium and distributed to consumers over a wide range of territory. Only a small per cent of the sweet corn exposed for sale was found to be infested and of this amount only a very small portion was shipped out of the infested area, but the danger existing from the possibility of the species being disseminated in this manner may be considered very great.

Cornstalks as Feed for Livestock. Another method of possible dissemination of the species is through the transportation of infested cornstalks. Many of the large market gardeners within the infested area sell their sweet corn fodder to owners of livestock after the ears have been harvested. Unless badly infested by the insect this fodder serves as a green and succulent feed which is greatly relished by livestock, especially dairy cows. Frequently this fodder is transported considerable distances by auto trucks and in several instances under observation infested material of this kind was taken to localities not previously infested by the insect.

Dry Cornstalks as Packing Material. Dry cornstalks are frequently used as rough packing material in the shipping of large articles of a fragile nature, and in this manner infested material may be carried for considerable distances. The over-wintering larvæ of the European Corn Borer are able to survive almost any extremes of cold, heat or drought within cornstalks, and are not inconvenienced by rough handling or being confined in a small space. They remain in a dormant condition within their host plant for a period of almost five months, from December until the following May, thus providing a long period of time during which they may be transported, with the consequent danger of their widespread dissemination.

Corn on the Cob. The larvæ of the European Corn Borer tunnel through the cobs of corn and frequently pass the winter in this situation. They are not at all inconvenienced by the drying out of corn stored on the cob, either for seed or for the feeding to livestock, and resume their feeding in the interior of the cob on the advent of warm weather in the spring.

Very little corn on the cob is shipped from the infested area but this means of possible dissemination must be considered.

Quarantine Measures Restricting Transportation of Infested Material. In order to prohibit the transportation of ma-

terial from corn plants infested by the European Corn Borer, Quarantine Order No. 36 was issued by the Federal Horticultural Board and became effective October 1, 1918.

This quarantine prohibits interstate movements of all corn fodder, or corn stalks, whether used for packing or otherwise; green sweet corn; roasting ears; corn on the cob; and corn cobs from the towns within the area infested by the European Corn Borer.

The State of Massachusetts is now preparing to institute a similar quarantine which will prohibit the intrastate movements of such infested material.

Danger of Spread through Transportation of Infested Material Other than Corn and Corn Products

If corn were the only plant attacked by the European Corn Borer the problem of restricting the spread of the insect would be comparatively simple; but several of the other host plants present additional openings by which the pest may be transported through the ordinary avenues of trade.

In badly infested areas the larger larvæ of the European Corn Borer frequently leave their original host, whether it be corn or some of the weeds or grasses, and enter other plants growing in the vicinity. This change of habitat is generally due to the fact that the food supply in the original host has been exhausted. Under these circumstances the larvæ may attack and enter almost any plant growing in the vicinity and possessing a moderately soft and succulent stem.

In home gardens, and in market garden areas it is a common practice to grow several crops close together, or inter-rowed in the same area. Sweet corn is almost always included among these crops and serves to attract the ovipositing females of the European Corn Borer. After the food supply in the corn plants has been exhausted the larvæ enter the other plants. In this manner the larvæ frequently infest celery, Swiss chard, spinach, beans, beets, potatoes, tomatoes, and some of the flowering plants including dahlias, gladiolus and chrysanthemums.

Celery

The outer stalks of celery are tunneled by the larvæ. As many as eight full-grown specimens were taken from a single stalk. During the process of harvesting celery most of these outer stalks are commonly removed and discarded. Stalks infested by the European Corn Borer are especially noticeable owing to their wilted appearance, but it is very possible that recently infested stalks may be overlooked by the ordinary workman and the insect transported to new localities through this medium.

Swiss Chard

The stalk and midrib of the leaf of Swiss chard are commonly tunneled by the larvæ. The injured leaves are very noticeable and are ordinarily discarded in preparing the crop for market. There is a possibility, however, that recently infested leaves may pass inspection and transport the pest to new areas.

Beans

The vines, immature seed and green pods of beans are tunneled by the larvæ of the European Corn Borer. The principal source of danger from the pest attacking this crop consists of the possibility that "string beans" containing larvæ of the species may be shipped to points outside the infested area.

Beets and Spinach

The tops of beets and spinach, or that portion of the plants commonly sold for greens, are sometimes infested by the pest. The larvæ tunnel in the stem and midrib of the leaf and frequently their injury is of such a nature that it may be overlooked by the workmen handling the crop, with the consequent danger of infested material being shipped to localities not previously infested by the insect.

Potatoes and Tomatoes

The vines of potatoes and tomatoes are frequently tunneled by the larvæ of the European Corn Borer but ordinarily this is not a source of danger in the possible dissemination of the species.

Dahlias, Gladiolus and Chrysanthemums

The stalks and flower stems of Dahlias, Gladiolus and Chrysanthemums are frequently entered and tunneled by larvæ of the European Corn Borer. The injury to these plants is of such a nature that infested stems generally wilt and break at the point where the larva enters; but large stalks or stalks recently infested do not show any conspicuous external indications of infestation and under certain circumstances may be included in shipments of these plants to points outside the infested area.

Methods Adopted for the Control of the Insect and its Limitation to the Area now Infested

It is evident that any measures looking toward the control of the European Corn Borer and its limitation to the area now occupied must consist of the destruction of the infested plants within that area, sup-

plemented by quarantine measures to prevent the dissemination of the species through the transportation of infested material.

These measures are now being applied to the solution of the problem and it is hoped that by their careful and intensive application the pest may be prevented from reaching the corn belt of the country and causing widespread injury to our most valuable crop.

Vice-President E. C. Cotton: Has anyone any questions to ask? We have just a short time which we can devote to discussion.

Mr. C. H. Hadley, Jr: To what extent can this pest be handled if it were to spread over the entire country?

Mr. D. J. Caffrey: The damage could be reduced by applying very strict clean-up methods, that would include all corn and weeds and grasses within the infested area. An ordinary farmer would need to destroy his old cornstalks in the same manner, get his neighbors to do the same, and give the waste areas a pretty thorough cleaning up.

Mr. W. E. Britton: I would like to ask about the expense of that treatment.

Mr. D. J. Caffrey: That would vary in the different sections. I should think possibly about ten dollars an acre. This would include treating weed areas.

Mr. W. E. Britton: That would be rather a large percentage on the cost of the growing corn.

Mr. D. J. Caffrey: Yes, it would be, and it would not necessarily be entirely effective either.

Mr. W. C. O'Kane: I should question whether, with our present knowledge, it can be economically controlled as a field proposition.

Mr. D. J. Caffrey: It is only under certain circumstances that the damage could be greatly prevented. As I pointed out from the first this illustrates the serious nature of the insect.

Mr. W. W. Chase: How do you spend the money in that way?

Mr. D. J. Caffrey: Generally we spend most of the money for labor. Take a large weed area for instance; in the spring when dried, weeds can be handled easily. You understand the entire plant must be destroyed. Of course that would be rather difficult during the fall when the plants are green, but in the spring the cost is considerably reduced because we can cover a larger area with a smaller force of men.

Mr. E. P. Felt: I would like to ask what are the possibilities of exterminating such a pest as this? Would it be economically practicable?

Mr. D. J. Caffrey: I think I can answer that question better perhaps two or three years from now.

Mr. E. P. Felt: The time to answer it is now.

Mr. D. J. Caffrey: That is a pretty hard question to answer at the present time. If we could reduce the entire area that is infested by the insect to a desert and absolutely destroy plant life, we could probably exterminate it in a short time.

Mr. W. C. O'Kane: Is it necessary to reduce the entire area to a desert?

Mr. D. J. Caffrey: Perhaps that statement should be amended to include the plants infested by the insects.

Mr. G. A. Dean: What are you going to do when an insect like this becomes established in a state or states like Illinois, Ohio, Indiana, Iowa, Nebraska, and Kansas, where they really have some corn fields? For instance, a man does not think he has a corn field unless he has more than forty acres. In Kansas at the present time there are over ten million acres of winter wheat. I should like to ask Mr. Walton whether he thinks it is possible to stamp out the infestation in Massachusetts, providing sufficient funds are available. Even though it should cost ten million dollars, what would that be compared with the injury or loss if this insect becomes established in the great agricultural states, where they grow corn, wheat, oats, and the kafirs?

Mr. W. B. Walton: From what we know regarding the control of this insect at the present time, I must confess that I am very skeptical respecting the possibility of exterminating it. I don't believe it can be done, but I am "willing to be shown."

Secretary A. F. Burgess: Is it worth trying?

Mr. W. R. Walton: Yes, of course, it is worth trying, when we learn how to do it. I don't think we are ready yet. The insect hasn't spread very much during the past year. We are now conducting experimental control work, and we know a good bit of its life-history. We don't know very much about the methods of controlling it. I should like to ask Mr. Caffrey to tell us something about the success of this work so far as it has been carried.

Mr. D. J. Caffrey: The control work as far as it has been carried shows that where we can get into an area where the plants are dry and start a good hot fire, we can absolutely destroy all parts of the plants. But in corn fields or weed areas where there are large weeds, more or less green, it is very difficult to destroy the larvæ.

Mr. W. C. O'Kane: How about pulling up the plants and burning them?

Mr. D. J. Caffrey: That was tried, the plants were placed in piles and we attempted to burn them with oil. When dry enough, they burn readily, but if they are very green it creates only a smudge, and we find a certain number of living larvæ left. Then we tried a large kerosene

torch, and that made pretty fair headway, when the vegetation was dry enough. In areas where there were large weeds and other large stems it became almost an impossibility to make any headway with that type of apparatus.

Mr. W. H. Goodwin: In my tests last summer with oils, I found that I could not use kerosene alone, but I could use kerosene in combination with a cheap lubricating oil known as a black oil. I found that in order to get rid of weeds and plants I had to almost thoroughly saturate the ground at the surface, and it must be nearly dry. When this mass of oiled vegetation was set afire even two or three days after spraying it burned to the ground. Now one of the problems with the Japanese beetles is to clean out those waste places. It looks to me as if this phase of the problem would apply to a certain extent to this corn borer, by getting rid of all waste places as far as possible in the area infested.

Mr. W. C. O'Kane: In order to complete my information I would like to know the total area infested this year and last year.

Mr. D. J. Caffrey: I can answer that question by saying that the original survey in 1917 was made by one man, who attempted to find out during his spare time the outside limits of the infestation and at that time he found that about a hundred square miles were infested. This was during the fall of 1917, right after the insect was discovered.

Now, last season we made a very careful survey during the spring, summer and fall, and found that all together about three hundred and twenty square miles were infested. That is quite an increase over the area that we found infested at first, but I am not satisfied that the hundred square miles was really the outside limit of infestation at that time. As I said, there wasn't time to make the original survey very thorough.

Mr. W. C. O'Kane: Have you data for saying that the insect has not spread very much during this past year?

Mr. D. J. Caffrey: We have in part of the area at least. I am referring to the limits south and west of Boston, where in some places it has spread only from a half to three quarters of a mile.

In many of the towns in the north that add greatly to the area infested we found only very few specimens after making a most exhaustive search.

Mr. W. R. Walton: In other words you are satisfied that the preliminary survey was very incomplete.

Mr. D. J. Caffrey: Yes, necessarily so, because there was very little time spent on it. I think Mr. Walton's statement that the spread of the insect has been comparatively slow is well founded. I might mention another case of a market gardener in West Medford who was a very observing man, an up-to-date grower in every respect, and he

claims that he has been severely injured by the pest in the last two or three years. If that is so, there must have been a considerable number of larvæ present during that time, and they must have gained entrance to his fields quite a few years previous to that. The outside limits extend about four miles beyond his farm now.

President E. D. Ball: It seems to me that if this insect is anywhere nearly as important as it has been represented to be, that even a minute of delay, to say nothing of a year, is serious, very serious, that while it may be spreading but a few miles a year, it has already spread over several hundred square miles and may spread in one big jump at any time, into the heart of the corn area.

We have several records of waiting too long before starting. The gipsy moth and the boll-weevil are good examples of this kind of folly. Here is a chance for the entomological fraternity to assert itself and with one voice, say that we are going after this insect and that we are going after it now. Suppose we fail—it is nothing. If we attack four insects and fail on three, but win on the fourth, we have won tremendously.

Corn is the biggest crop in America, and I think that the corn growers of the Mississippi Valley have a right to demand protection from this pest, and that every possible source of protection should be used at once. We have learned in this last year what it means to go into a thing and do it—not to wait and talk about it and say that it is impossible, but to do it. It seems to me that that should be our slogan today; let us go in and do it.

Secretary A. F. Burgess: I want to say one word in regard to spread. The corn borer is in the same region where the gipsy moth was originally introduced. The gipsy moth was introduced in 1868 or 1869, and it did not become a pest in the region where it was introduced until about 1890. During the time from 1890 to 1900, when work was carried on by the state of Massachusetts to clean out the gipsy moth, the largest area that it occupied was approximately the area that the corn borer occupies at the time. We did not know at that time—and we have only known for a few years—the principal method of spread of the gypsy moth.

The female moth does not fly; the principal method of spread is by the small caterpillars being blown by the wind immediately after hatching. The trend of spread is toward the north or northeast, but it took the gipsy moth, even with the small caterpillars being capable of blowing twenty miles, approximately twenty-five years to occupy the territory that is now occupied by the corn borer. If the statements made are correct in regard to the time of introduction, in all probability the corn borer has not been in this country more than five or six years.

I simply mention this to show that there may be more possibility of rapid spread of the corn borer than we think at present.

Another factor in connection with the spread is this: When you get a large area heavily infested the spread will be much more rapid than when the area is small even if it is well infested. These are factors in the problem that should be considered.

Mr. R. K. Beattie: There is a parallel in the White Pine Blister Rust that I wish to call to your attention. For four or five years the Office of Forest Pathology of the Bureau of Plant Industry tried to get people interested in the eradication of the White Pine Blister Rust. At that time its area of distribution in the United States was small. Because the disease was spreading slowly, people ignored it and no one could be interested in combating it. Suddenly it became epidemic. In two years it had spread so rapidly that the cleaning up of the White Pine forests of New England was impossible. Before that epidemic, anyone would have said that New England could be cleaned up. Now, such an effort is made only in isolated localities. I cannot say that there is necessarily parallelism between plant diseases and insects, but in both groups we do have epidemics. We have had entirely too many cases in this country among plant diseases where we have tried to find out scientifically all about the disease before we began to fight it. When citrus canker first appeared in the United States some pathologists believed its study should be completed before the work of combating it began. But the fight was really begun on this disease while it was still thought to be caused by a fungus. Later, its bacterial cause was discovered after the campaign of eradication was well under way. Happily in this case the campaign has been very successful and the disease has been almost completely eradicated. If they had waited until they found out all about it we would never have gotten rid of citrus canker.

Mr. W. H. Goodwin: Naturally I am interested in the Japanese beetle, that has been established practically for eight years, and I believe it is a good time to wipe it out while we have a chance. We must stamp it out or it will get away, and it has got to be handled sufficiently rough to get rid of it in the next two or three seasons.

Mr. W. C. O'Kane: I would like to have the permission of the association to propose the following motion: That this association endorse the utmost possible measure of eradication of the European corn borer, and further endorse the proposition of asking Congress for sufficient appropriation to undertake immediately a competent campaign of eradication under Federal direction. Motion seconded.

Mr. E. P. Felt: I want to go on record as representing an adjacent state, in favor of going to the limit.

Mr. H. A. Reynolds: I want to say for the American Plant Pest Committee, which is an outgrowth of the Committee on the Suppression of the Pine Blister Rust, that we have held a meeting of all the state agricultural commissioners and state entomologists in New England, and it was unanimously agreed that we should try extermination. Nobody knows whether we can exterminate this pest or not, but we feel that with a three billion dollar crop at stake, we can afford to spend five hundred thousand to a million dollars a year eternally to keep it confined to Massachusetts.

Mr. Beattie brought up a very interesting proposition which appeals to me. He said that the government tried to get the fellows out in the states interested in the blister rust for years, and I know that is true, but now it seems in this case the situation is reversed. We feel that the department at Washington wants to put in only twenty-five to thirty thousand dollars, as they have told us, for investigation. I have the highest respect for investigators, but since we know one way of dealing with the pest, it seems to us in New England that we ought to go ahead and kill all of them we can during the time we are making the investigation, and it has been proposed that we ask for an appropriation of five hundred thousand dollars for that work, this coming year. We were to have a conference here today. Dr. Marlatt, I understand, is not able to appear. I do hope that this organization will go on record to back up the American Plant Pest Committee in this proposition.

Mr. W. E. Britton: Mr. Burgess might have told us more about the experience in Massachusetts of fighting the gipsy moth and how the state kept up the work for ten years and then stopped for five, and he might have told you the number of hundreds and thousands of square miles that the insect occupied when they took up the work again in 1905 or 1906.

I had the privilege of visiting Massachusetts in September last, and looking at some of the infested corn in the vicinity and just west of Boston. In my opinion, this is one of the most dangerous insects which has ever been introduced into this country, and I believe it is twenty-five times more dangerous than the pine blister rust ever was, or ever will be. It is a question whether it can ever be exterminated, but we never know whether we can do anything until we try. It is certain that if it ever can be exterminated, it can be done now much easier than it can be five or ten years from now.

I am in favor of a large appropriation, and of making a strenuous attempt to exterminate that insect, and I expect that we can at least hold it where it is for a long time. Of course, if we fail, that is a thing which we may do in any attempt which we may make, but I believe it is

certainly worth while, and if we do not make an attempt we will be criticized years later because we did not make it. I am in favor of a large appropriation, made as soon as we can get it.

Mr. G. A. Dean: It seems to me that this is the very thing to do. In my mind, we have never had a better opportunity to get the entomologists all over the country working together like the parts of a machine.

Last evening, in fact, all through these meetings we have been saying we will never get anything unless we go after it. Now, here certainly is an opportunity to go after something. I would rather fail a half dozen times than have it said I never tried. Speaking now for Kansas, I feel that if we want to get our senators and representatives in Congress interested in insect control, just bring to their attention, and convince them that an insect is threatening the corn, wheat, oats, and kafir crops. This at once touches powerful constituents, the farmer and the stockman. With the splendid organization that many of the entomologists have through the county farm bureaus, and the extension divisions, they can now put things across that were not possible a few years ago. A state institution with a farm bureau in nearly every county, with a membership including practically all the leading farmers and stockmen, can bring a powerful influence to bear on their congressmen and get almost any reasonable thing they desire.

Mr. T. H. Parks: It seems to me we should not consider the money lost if the attempt to eradicate this insect in Massachusetts is not successful. The work will, of necessity, show how to control the insect in small areas. If it is delayed a few years in getting into the corn belt, the money will be well spent.

Mr. P. J. Parrott: My confidence in the work of quarantine inspection was greatly increased by the efficient efforts of the federal and state authorities in wiping out the gipsy moth in Geneva. I had no idea when they undertook this work that they could ever clean up Geneva and prevent the dissemination of the insect in Geneva and outlying counties. I heartily endorse the sentiments that have been expressed, as I believe we are confronted with a serious problem that demands concerted action by the state and national authorities. We have had in the past many failures in efforts of this character because work was started too late. Now that we have state and federal organizations that are well equipped for the undertaking, I hope very much that they secure adequate funds and that the attempt be made to restrict this insect to the present area and if possible exterminate it.

Secretary A. F. Burgess: Professor Parrott spoke about the extermination of the gipsy moth at Geneva. That was done because we had the organization and money to do it; the same is true of colonies

at Cleveland, Ohio, Rutherford, N. J., Mt. Kisco, N. Y., Wallingford, Conn., and in the Berkshires in Massachusetts. It has not been done in the big area because there is not the money to do it at the present time.

By vote of the association the motion was carried.

Adjournment.

(Papers read by title.)

BIOLOGICAL NOTES ON SOME FLATHEADED BARKBORERS OF THE GENUS MELANOPHILA

By H. E. Burke, *Specialist in Forest Entomology, Forest Insect Investigations, Bureau of Entomology, United States Department of Agriculture*

Among the flatheaded barkborers most destructive to forest trees are several species of the genus Melanophila. One species, *M. drummondi,* is of particular interest at the present time because it attacks the sitka spruce which is so necessary in the manufacture of aeroplanes. This and other species, *M. gentilis, M. fulvoguttata* and *M. californica,* attack and kill some of our most important coniferous forest trees. Many sugar pine, yellow pine, douglas spruce, true firs, true spruces, hemlocks and larches in American forests have been killed at various times past and are now being killed by these pernicious pests. Even should an attack not kill the tree the injury made often causes checks, "gum spots" or other defects to form in the wood which reduces its value for timber.

A curious injury to sugar pine and yellow pine timber in northern California consists of a brown, pitchy, irregular scar several inches in diameter from which radiates small, winding, pitchy lines. The forest pathologists consider the central scars to be caused by a light or diffused stroke of lightning which slightly separates the bark and wood. The radiating lines are the mines of Melanophila larvæ whose mothers were attracted to the scars to lay their eggs. When the attack failed the larvæ died and the new growth covered the wound, forming the curious defect.

Dr. A. D. Hopkins has published notes on the injuries caused by several species of Melanophila in bulletins 32 and 56 of the West Virginia Agricultural Experiment Station and 21, 37, 48 and 53 of the Bureau of Entomology. The writer has mentioned them in the United States Department of Agriculture Yearbook for 1909 and in papers in the Journal of Economic Entomology for June, 1917, and April, 1918. Many other observations have been made from time to time by various members of the Branch of Forest Insect Investigations. The present paper is a summary of the data obtained from all of the above notes.

As a general thing the species of the genus Melanophila have one generation a year. Beetles emerging from the trees in the spring and summer of one year lay eggs which hatch into larvæ that live over the winter and pupate and transform to beetles that emerge the spring and summer of the next year. Sometimes, however, part of the larvæ of one generation will remain in the pupal cells for several years before pupating and transforming to beetles. On June 13, 1915, Mr. F. B. Herbert collected at Placerville, California, some *M. gentilis* prepupal larvæ which held over until March 24, 1917, before pupating and transforming. This would be about three years in the larval stage. Frequently some larvæ are found in trees from which the main brood has emerged a year or more.

All of the species studied in the United States are barkborers. The larvæ mine in the inner bark and outer wood and pupate in cells in either the bark or wood. The eggs are laid in the crevices of the bark between the scales. The beetles usually feed on the bark or foliage of the host trees but Ricksecker mentions (*Entomologica Americana*, 1885) having seen adult *M. consputa* devouring scorched termites.

Except in one instance where the writer reared a specimen of *M. acuminata* from the monterey cypress (Cupressaceæ) all of the American species of Melanophila appear to confine themselves to host plants of the family. Pinaceæ.

The larval characters indicate that the genus should be divided into two. The true Melanophila type of larva such as occurs in *acuminata*, *consputa*, *gentilis*, *drummondi*, *fulvoguttata*, *californica* and *piniedulis* has characters which make it generically distinct from the *intrusa* larva. In the first case the rugose areas on the plates of the first thoracic segment are broad while in the larva of *intrusa* and *aeneola* they form narrow borders along the grooves of the plates.

At the present time the only method of fighting these insects in the forests is to control them by burning the infested wood and bark before the adults emerge and attack new trees. Parasites and predators commonly attack them, however, and as our knowledge of these increases, and improved methods of forestry are put into practice, Melanophila depredations should be prevented before they have to be controlled.

Melanophila miranda Lec.—Leconte gives Fort Union, New Mexico, as the type locality. Horn says that it occurs from Oregon to Texas in the mountain regions. Considerable collecting has been done in the forested areas of these regions by members of the Branch of Forest Insect Investigations but no specimens have been taken. The species is thus extremely rare or it does not infest the common forest trees.

Melanophila notata Lap. and Gory—Middle and Southern States is the range given by Leconte, Horn says Georgia and Florida and Blatchley adds Marion County, Indiana. So far we have made no records on this species.

Melanophila acuminata De Geer—Appears to be same as *longipes* Say and *atropurpurea* Say; Wisconsin, South Dakota, Colorado, Idaho, Washington and California; mines inner bark and outer wood of injured, dying and dead trees; pupates in wood; red or Norway pine (*Pinus resinosa*), lodgepole pine (*P. murrayana*), monterey cypress (*Cupressus macrocarpa*); taken on the bark of yellow pine (*Pinus ponderosa*), engelmann spruce (*Picea engelmanni*), sitka spruce (*P. sitchensis*), lowland fir (*Abies grandis*), giant arborvitæ (*Thuja plicata*); flies from May to October; pupates during spring and summer; adults common in smoke of forest fires; prefers to attack trees scorched by fire.

Melanophila consputa Lec.—Northern to central California; mines inner bark and outer wood of injured, dying and dead trees; pupates in either bark or wood; yellow pine (*Pinus ponderosa*), lodgepole pine (*P. murrayana*), monterey pine (*P. radiata*), knobcone pine (*P. attenuata*); pupates during spring and summer; flies from April to October; common during late summer around burned areas; prefers to attack trees scorched by fire; sometimes annoys workmen around sawmills and smelters by alighting on them and pinching the hands or face with its mandibles.

Melanophila gentilis Lec.—South Dakota, Colorado, New Mexico, Montana, Utah, Arizona, Idaho, Oregon, California; mines inner bark and outer wood of normal, injured, dying and dead trees; pupates in bark or outer wood; sugar pine (*Pinus lambertiana*), yellow pine (*P. ponderosa*), rock pine (*P. scopulorum*), jeffrey pine (*P. jeffreyi*); flies from March to August; pupates from March to July; attacks and kills small and large trees; very injurious to second growth in some localities; is one of the most injurious enemies of its host plants.

Melanophila drummondi Kirby—Montana, Colorado, New Mexico, Idaho, Utah, Arizona, Washington, Oregon, California; mines inner bark and outer wood of normal, injured, dying and dead trees; pupates in bark or wood; western larch (*Larix occidentalis*), engelmann spruce (*Picea engelmanni*), sitka spruce (*P. sitchensis*), western hemlock (*Tsuga heterophylla*), alpine hemlock (*T. mertensiana*), douglas spruce (*Pseudotsuga taxifolia*), alpine fir (*Abies lasiocarpa*), lowland fir (*A. grandis*), white fir (*A. concolor*), lovely fir (*A. amabilis*), noble fir (*A. nobilis*), red fir (*A. magnifica*); flies from May to September; pupates from February to June; attacks and kills many trees; causes defects to form in the wood of others which it attacks but fails to kill.

Melanophila fulvoguttata Harris.—Maine, New Hampshire, Michigan, West Virginia, North Carolina; mines inner bark and outer wood of normal, injured, dying and dead trees; usually pupates in the bark; spruce (*Picea* sp.), red spruce (*P. rubens*), hemlock (*Tsuga canadensis*); flies from May to August; pupates from April to July; attacks and kills many trees and seriously injures others; is the most destructive enemy of the eastern hemlock as has been pointed out by Dr. Hopkins in Bulletin 37 of the Bureau of Entomology.

Melanophila californica Van Dyke—Idaho, Oregon, California; mines inner bark and outer wood of normal, injured, dying and dead trees; pupates in bark and wood; yellow pine (*Pinus ponderosa*), jeffrey pine (*J. jeffreyi*), digger pine (*P. sabiniana*), coulter pine (*P. coulteri*), monterey pine (*J. radiata*) knobcone pine (*P. attenuata*); flies from May to August; pupates from March to July; attacks and kills many second growth trees and assists barkbeetles to kill others.

Melanophila pini-edulis Burke—Colorado, Utah, Arizona; mines inner bark and outer wood of normal, injured, dying and dead trees; pupates in outer wood; pinon (*Pinus edulis*); flies from June to September; pupates from June to July; assists barkborers and barkbeetles to attack and kill trees.

Melanophila intrusa Horn—Colorado, California; mines inner bark and outer wood of injured, dying and dead trees; pupates in outer wood; sugar pine (*Pinus lambertiana*), yellow pine (*P. ponderosa*), rock pine (*P. scopulorum*), knobcone pine (*P. attenuata*); flies from June to July; pupates from March to June; usually lives in the suppressed limbs of living trees but sometimes attacks saplings, especially those over-topped by larger trees.

Melanophila æneola Melsh.—West Virginia, North Carolina; mines inner bark and outer wood of dying and dead trees; pupates in the wood; scrub pine (*Pinus virginiana*), pine (*Pinus* sp.); flies from April to August; infests overtopped branches and trees.

Melanophila obtusa Horn—One specimen from Georgia recorded by Horn in his revision of the genus. No specimens have been collected by us.

THE LIFE-CYCLE OF LACHNOSTERNA LANCEOLATA SAY[1]

By William P. Hayes, *Assistant Entomologist, Kansas State Agricultural Experiment Station*

Introduction

Because of the growing importance of *Lachnosterna lanceolata* Say as a pest of growing wheat in Kansas and Oklahoma, the life-history study herein reported was taken up as a part of the Kansas Experiment Station project "Insects Injurious to the Roots of Staple Crops." This project aims ultimately to work out the life-histories of all other Kansas species of *Lachnosterna* and related genera as well as wireworms and other underground pests of staple crops growing in the state. The work is being carried out under the immediate direction of Mr. J. W. McColloch, to whom thanks are due for his kindly aid and criticism.

History and Importance

Lachnosterna lanceolata Say, an important enemy of growing wheat in Kansas and Oklahoma, was originally described as *Melolontha lanceolata* Say (1824, p. 242), from specimens collected near the Rocky Mountains. The remark being added that it inhabits Missouri and "Arkansa." Since then it has been placed in three other genera—*Tostegoptera*, *Lachnosterna*, and *Phyllophaga*.

This insect is destructive both in the larval and adult stages. Cockerell (1895, p. 69) first reported adults injuring growing cobs of corn in New Mexico. Howard (1900, p. 107) reported the adults attacking collards in Texas, and stated that they had been "noticed more or less since 1890. Their principal food was stated to be 'careless weed' (Amaranthus), two or three species of which grow commonly in or near cornfields." Sanderson (1904, p. 95) stated that the beetle often occurs in large swarms and eats off young cotton plants on considerable areas. In 1905 (p. 13) he again mentions the injury to young cotton, as well as "various other crops, especially garden truck, in the arable land west of the ninety-seventh meridian." It is regarded as most injurious in west central Texas. The wild sunflower (*Helianthus*) is added as a food plant. The same writer (1906; p. 18) attempted to rear the species and succeeded in hatching four eggs. The resulting larvæ fed on cotton and grass roots during the summer and fall. This apparently comprised the total of our knowledge of the

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[1] Contribution from the Entomological Laboratory, Kansas State Agricultural College, No. 35. This paper embodies the results of some of the investigations undertaken by the author in the prosecution of project No. 100 of the Kansas Agricultural Experiment Station.

habits of this insect until the appearance of the notable work on the life-histories of *Lachnosterna* by Davis. This writer (1916, p. 276) successfully reared one specimen to the adult stage in two years, but the length of the various stages were not noted. He also writes of the grubs as injuring wheat in Kansas.

During the past few years the grubs of this species have come into prominence every fall soon after wheat planting time in southern Kansas and northern Oklahoma where they annually damage thousands of acres of young winter wheat. During the past fall their damage has been especially severe in southern Kansas. In the fields they often work in small patches which enlarge the following year. Grubs of various sizes are to be found in the fields and are frequently so abundant that a single handful of soil will contain three or four grubs. In other parts of the state the grubs and beetles are found abundantly in the native grasslands and are often a serious pest of pasture grasses. One instance was noted where the beetles were found feeding on growing oats.

Distribution

Lachnosterna lanceolata is practically confined to the region bounded on the west by the Rocky Mountains, and on the east by the Mississippi River. Specimens have been reported as taken in South Dakota, Nebraska, Colorado, Kansas, Missouri, New Mexico, Oklahoma, Arkansas, and Texas. Forbes (1894, p. 139) lists the species as rare in central and southern Illinois. This was the only record found of its occurrence east of the Mississippi River.

The spread of this species is naturally slow. The females are wingless and cannot travel far. One specimen was once observed being carried by high water in a small stream. Local distribution in Kansas varies markedly in the northern and southern parts of the state. In the northern part of the state the species is, with rare exceptions, confined to the higher upland fields and pastures, while in southern Kansas the adults and grubs are found in the lower wheat lands of that region.

Life-Cycle

Egg.—The eggs of this species are laid singly or in small groups of three or four in clumps of soil, preferably undisturbed or covered with vegetation, at depths ranging from 1 to 7 inches. The eggs are white in color and when freshly laid are oval in shape, about 2 mm. long, but in the course of a few days they assume a globular shape and increase slightly in size, becoming about 2.8 mm. in diameter. The length of the egg stage was found to vary from 9 to 29 days with an average of 16 days. Table I shows the maximum, minimum and average length of the egg stage obtained in three seasons.

TABLE I—SHOWING LENGTH OF THE EGG STAGE

Year	No. to Hatch	Maximum Length of Stage, Days	Minimum Length of Stage, Days	Average Length of Stage, Days
1916	630	19	10	14.1
1917	93	29	10	17.1
1918	813	22	9	16.4
General average				16.0

Oviposition begins the latter part of June and extends into the first weeks of August. The earliest eggs laid under artificial conditions were found in cages June 25 and the last eggs August 9. The exact number of eggs laid by single individuals has not been determined. One isolated female laid nine eggs and another laid fifteen. This number is undoubtedly below the average. A few days before hatching the young larva can be seen through the shell of the egg.

LARVA.—The newly hatched larva is about 2 or 3 mm. long, pure white in color, with a white head which rapidly turns to a light brownish color. Soon after feeding begins, a black meconium appears at the posterior end of the alimentary tract. These grubs grow much slower than other two-year grubs of the genus *Lachnosterna* and at the end of the first growing season are much smaller. There is this difference, however: the *lanceolata* grubs pupate in the spring and must live through two winters, whereas other so-called two-year grubs pupate in the fall after having passed through only one winter.

When full grown the grubs shed the meconium of the alimentary tract and pass through a quiescent or semi-pupal stage. Almost two full years are required for the grubs to reach maturity. Table II shows the length of the larval and semi-pupal stages as worked out at Manhattan, Kansas.

TABLE II—LENGTH OF THE LARVAL, SEMI-PUPAL, AND PUPAL STAGES

Rearing Number	Date Hatched	Date Became Semi-Pupa	Date Pupated	Date Became Adult	Length of Larval Stage: Months	Days	Length of Semi-Pupal Stage, Days	Length of Pupal Stage, Days	Sex
1694	7-16-16	6- 1-18	6- 8-18	6-24-18	22	15	7	16	♀
1776	7-16-16	5-27-18	6- 4-18	6-21-18	22	11	7	17	♀
1777	7-16-16	5-31-18			22	14			
1870	7-17-16	6- 1-18	6-10-18	6-24-18	22	14	9	16	♂
2157	7-20-16	6- 1-18	6-10-18	6-25-18	22	12	9	15	♂
2530	7-21-16	5-27-18	6- 7-18	6-24-18	22	3	11	17	♀
2614	7-24-16	6- 3-18	6-10-18	6-25-18	22	10	7	15	♂
2713	7-23-16	5-31-18	6-10-18	6-25-18	22	8	10	15	♂
2819	8- 1-16	6-12-18	6-17-18	7- 1-18	22	11	5	14	♂

The maximum length of the larval stage, as shown by Table II, was 22 months and 15 days, and the minimum was 22 months and 3 days. The semi-pupal stage varied from 5 to 11 days.

The first larvæ begin hatching during the first and second weeks of July and continue until the latter part of August. The earliest egg to hatch in life-history cages was July 8, and the last August 28.

The grubs were reared to maturity on germinating wheat grains in ordinary salve boxes. The mortality was high. Over 700 boxes, each with a single grub, were started in 1916. Of these only 9 reached the semi-pupal stage, and 8 the pupal stage. A few 1916 grubs lived until September 1, 1918, indicating a possible three-year life-cycle in some cases.

The possibility of a three-year life-cycle is also indicated by observations made in Harper County, Kansas, during the fall of 1918. In the northern part of the county three distinct sizes of grubs were found in almost equal numbers in nearly all infested fields. In the southern part of the country only two sizes—first year and full grown—were found.

Fig. 5. *Lachnosterna lanceolata* adults: *A*—Male; *B*—Female.

Pupa.—The pupa resembles any other pupa of the genus *Lachnosterna*. It is about 18 mm. long and 9 mm. wide. When freshly transformed it is pure white in color. It gradually darkens until just before emergence the color of the adult appears through the pupal skin in many places. Table III shows the length of the pupal stage of sixteen individuals collected as grubs at various times.

TABLE III—SHOWING LENGTH OF THE PUPAL STAGE

Rearing Number	Date Pupated	Date Became Adult	Sex	Length of Pupal Stage, Days
2061	6-12-16	6-30-16	♂	18
2943	7-12-17	7-28-17	♂	16
2964	6-16-17	7- 6-17	♀	20
3106	7-27-17	8- 8-17	♀	11
3107	7-16-17	7-24-17	♀	8
3108	6-22-17	7-11-17	♀	19
6	7-18-16	7-27-16	♂	9
3021	6-11-18	6-24-18	♀	13
3022	6-27-18	7-10-18	♀	13
3024	6- 7-18	6-21-18	♀	14
3027	6- 7-18	6-22-18	♂	15
3030	6-10-18	6-24-18	♀	14
3043	6-14-18	6-26-18	♀	12
3081	6-20-18	7- 2-18	♀	12
3083	6-10-18	6-22-18	♂	12
3155	6- 5-18	6-20-18	♀	15

The minimum length of the pupal stage was found to be 8 days, and the maximum 20 days. An average of the figures in Table III gives 13.8 days as the average length of the pupal stage.

ADULT.—The adult of this species is an exception among the May-beetles in that it is a day flier, pupation occurs in the early summer rather than in the fall, the adults do not live over winter and the females are wingless. The adult beetles (Fig. 5) are brown in color and when freshly transformed are covered with small lanceolate cinereous scales which rub off when abraded, leaving a few scales to form discal vittæ on the elytra.

The beetles vary in size from 13 to 17 mm. The females are much larger than the males and are strongly ovate in form, while the male is more oblong with its sides nearly parallel. Since the genitalia of *Lachnosterna* are strong taxonomic characters, those of *L. lanceolata* are shown in Figure 6.

In the vicinity of Mahattan, Kansas, adults are abundant in pasture land from the early part of June to the last of July. The females are to be found crawling on the ground or up the stems of pasture plants. The males are strong fliers and fly from plant to plant. Mating occurs on the surface of the soil or on plants. The proportion of sexes of over nine thousand individuals collected in two summers was found to favor the females one year and the males the next. The beetles fly and crawl from early morning till the hotter parts of the day, at which time they burrow into the ground to avoid the heat.

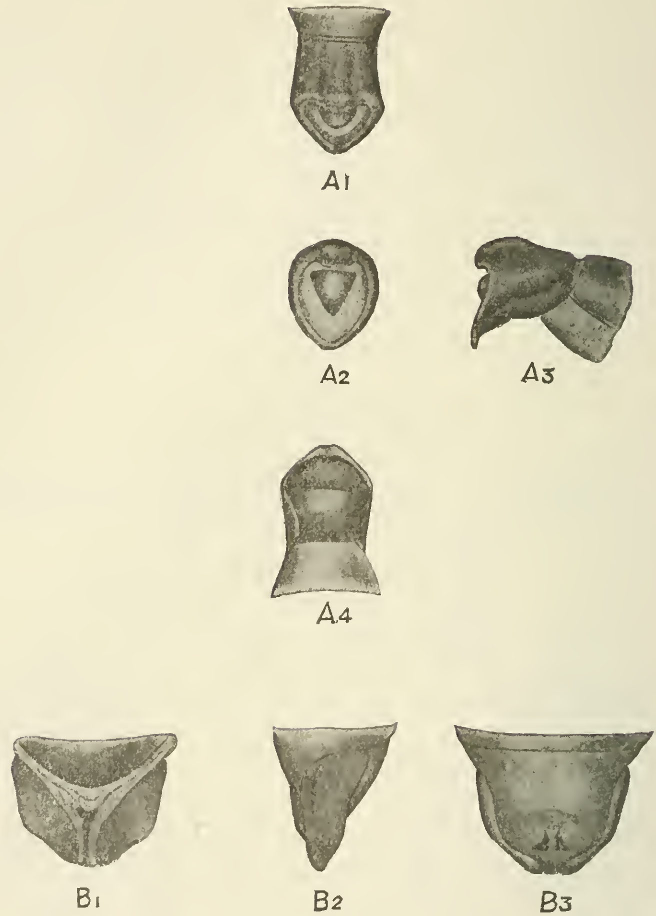

Fig. 6. Genitalia of *Lachnosterna lanceolate:* *A*—Male; *B*—Female; A_1—Dorsal aspect; A_2—Caudal aspect; A_3—Lateral aspect; A_4—Ventral aspect; B_1—Ventral aspect; B_2 Lateral aspect; B_3—Dorsal aspect.

Length of Life-Cycle

To summarize the life-cycle of a single generation of *L. lanceolata,* we find the beetles appearing and laying eggs during June and July. The eggs hatch in July and August. The average length of the egg stage was found to be 16 days. Larvæ are present until June of the second year, giving a larval stage of slightly over 22 months. Pupæ occur in June and July with an average stage of 13 days. Two full years are thus required for development, and, in some cases, where the larval stage is prolonged, three years may be required. However, two

years seems to be the normal length of the life-cycle in Kansas. The generations overlap each other so that all stages appear every season. This is evident from the large number of adults present each year. Table IV shows the number of beetles collected at Manhattan, Kansas, during the past three seasons.

TABLE IV—RECORD OF COLLECTIONS OF ADULTS

Year	1916			1917			1918		
	Males	Females	Total	Males	Females	Total	Males	Females	Total
Number	557	1506	2063	1529	2004	3533	3322	2382	5704

FOOD PLANTS

The adult beetles are quite general feeders and have been observed eating a variety of different plants. From the literature, cotton, corn, wild sunflowers, collards, and careless weed (Amaranthus) are reported as food plants. Table V lists a number of plants on which the adults were observed feeding.

TABLE V—FOOD PLANTS OF *Lachnosterna lanceolata*

Observed Feeding in the Fields	Observed Feeding in Cages
Pigweed—*Amaranthus* sp.	Pigweed—*Amaranthus* sp.
Crab grass—*Panicum sanguinale*	Sunflower—*Helianthus* sp.
Evening Primrose—*Oenothera biennis**	Corn—*Zea mays*
Pepper grass—*Lepidium* sp.	Evening Primrose—*Oenothera biennis**
Corn—*Zea mays*	Elm—*Ulmus americana*
Bindweed—*Convolvulus* sp.	Cherry—*Prunus* sp.
Bladder Ketmia—*Hibiscus trionum*	Sumach—*Rhus* sp.
Ironweed—*Vernonia baldwinii**	Willow—*Salix* sp.
Shoestring plant—*Amorpha canescens**	Oats—*Avena sativa*
Sumach—*Rhus* sp.	Brome-grass—*Bromus inermis*
Clover—*Trifolium* spp.	Foxtail—*Setaria* sp.
Little Ragweed—*Ambrosia psilostochyla**	Smartweed—*Polygonum* sp.
Vervain—*Verbena stricta**	Apple—*Pyrus malus*
Hoary Aster—*Aster sericeus**	Kafir—*Andropogon sorghum*
False boneset—*Kuhnia eupatorioides**	Crab grass—*Panicum sanguinale*
Sampsoni snakeroot—*Psoralea pedunculata**	Pepper grass—*Lepidium* sp.
Golden rod—*Solidago rigida**	Milo—*Andropogon sorghum*
Oats—*Avena sativa*	Peach—*Prunus persica*
Liatris (spicta?)	Curled dock—*Rumex crispus*
Venus' looking glass—*Specularia perfoliata**	Beet—*Beta vulgaris*
Thistle—*Cirsium* sp.	Bean—*Phaseolus vulgaris*
Yarrow or Milfoil—*Achillea millefolium**	Potato—*Solanum tuberosum*
Little Blue Stem Grass—*Andropogon scoparius*	Cabbage—*Brassica oleracea*
Sunflower—*Helianthus* sp.	Tomato—*Lycopersicum esculentum*
Alfalfa—*Medicago sativa*	Peas—*Pisum sativum*
Cocklebur—*Xanthium* sp.*	Bladder ketmia—*Hibiscus trionum*
Big Blue Stem Grass—*Andropogon furcatus*	

It is interesting to note that the adults were frequently found feeding abundantly on wild clover while an adjacent alfalfa field was always

* Det. H. F. Roberts

free of the beetles. However, in Dickinson County, Kansas, one specimen was found feeding on alfalfa. In pasture land, ironweed (*Vernonia baldwinii*), Evening primrose (*Oenothera biennis*), and white clover (*Trifolium repens*) are apparently important food plants. The beetles are to be found abundantly near those plants. There is some evidence that the females prefer to lay their eggs at the base of the ironweed plants. In one case 81 eggs were found within a radius of two inches from an ironweed plant and in the first eight inches of soil.

Natural Enemies

Natural enemies are not abundant in Kansas. None of the common parasites of *Lachnosterna* have yet been noted. However, one adult of a Sarcophagid fly, *Sarcophaga prohibita* Ald., was reared by J. J. Davis from material sent him by the writer. This is his first record of this species from *Lachnosterna* and he believes it a true parasite as the species is one of the group of true parasitic Sarcophagids.

Control Measures

The methods of control for this and other white grubs have not been clearly worked out as yet, owing to the fact that the grubs live entirely below the surface of the ground, and that they require two or three years to complete their development. One of the striking features in the injury to wheat by *lanceolata* is that the damage is occurring in those fields that have been in wheat for a period of years. The injury seems to be cumulative, increasing in severity from year to year. This is due to the fact that the females are wingless and do not leave the field, but deposit their eggs in the same area from which they emerged.

One of the best means of control thus far known is that of rotation of crops. The planting of corn or sorghums on infested land has often served to eliminate the field of grubs in one year. Another factor in the use of corn and sorghum is that repeated working of the ground destroys the grubs in large numbers. A rotation of corn, oats and wheat has proved very effective in prevention of damage by this species. A striking example of the effectiveness of such a rotation was observed by Mr. J. W. McColloch in Harper County, Kansas, in the fall of 1918. An 80-acre field that had been in wheat continuously until 1917 was divided into a north and south half. The north half was allowed to remain in wheat. The south half was planted to corn in 1917, to oats in the spring of 1918, and wheat the same fall. At the time of writing (November, 1918) the north half of the field is a total loss while in the south half there is scarcely a plant missing. On the west of this particular field there is another field that has been in wheat for three years. A few grubs are present, but not enough to injure the crop.

In the practice of rotation for the control of this species it is evident that a change in the cropping system is hardly necessary more often than once in five years.

Where the area infested is small, it has been found practical to allow hogs to run on the field temporarily. Hogs show a great preference for white grubs, and will root to a depth of several inches to get them.

Plowing immediately after harvest, and keeping the ground free from all vegetation during the summer is always practical, since this procedure will deprive most of the grubs and the adult beetles of food. The keeping down of weeds around the edge of the field will also deprive the adults of food.

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RECENT RESULTS IN THE FUMIGATION OF CITRUS TREES WITH LIQUID HYDROCYANIC ACID

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The fumigation of citrus trees with hydrocyanic acid gas has been performed in California for more than thirty years and during this period more radical changes in apparatus and methods have occurred than is to be found in the annals of any other insecticide either in this state or elsewhere. The original so-called "dry gas" process in which undiluted sulphuric acid was poured slowly into a cyanid solution, the resultant gas passing through a sulphuric acid bath, gave way in 1890

to the "pot method," which consists of placing dry cyanid with diluted sulphuric acid in an open vessel beneath the tented tree. In 1912 a simplified portable machine for generating cyanid gas outside the tent was invented and this method of application rapidly and successfully displaced the "pot method." The latest development, liquid hydrocyanic acid, has proved the most revolutionary of all changes in field fumigation, promising ultimately to completely supersede current practices.

In 1915 C. W. Mally,[1] working in South Africa, prepared and experimented with liquid hydrocyanic acid. It happened that William Dingle, of Los Angeles, one of the inventors of the machine method of generation, began to develop simultaneously but entirely independently the same method and, in the early spring of 1916, publicly demonstrated the fumigation of citrus trees with liquid hydrocyanic acid.

Liquid hydrocyanid acid is by no means new, having been known to chemists for many years. In its pure state it is a colorless liquid with a specific gravity of .70 at 65° F. The high volatility of this substance (it boils at 80° F.) produces easy gasification at the ordinary temperatures of fumigation. If impure it decomposes rapidly.

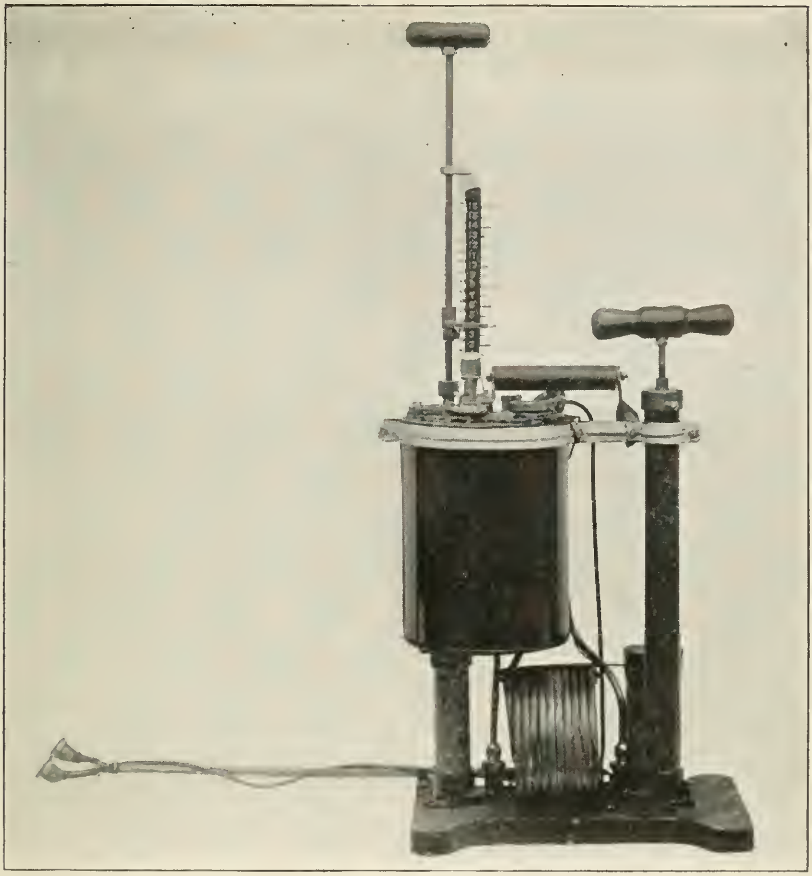
The application of this gas to the tented tree is extremely simple. A tank, suitably vented, holding about two gallons, is mounted on a platform with a measuring device and a pump (Pl. 4, Fig. 1). The liquid hydrocyanic acid, after measurement into storage coils, is forcibly discharged through a short rod fitted with a mist type of spray nozzle, and quickly disappears as an invisible gas.

During the season of 1917 approximately 540,000 pounds of solid sodium cyanid were converted into liquid hydrocyanic acid for the use of thirty fumigation outfits.[2] So far this year more than one million pounds of sodium cyanid have been similarly treated for the use of ninety-four fumigation crews.[2] A very much greater amount would have been used could it have been produced.

Gas Distribution

It has been the writer's belief for many years that gas distribution is influenced by the method of application or generation and in 1908 this led to the invention of a cover device[3] for deflecting the rise of gas from a generating vessel. In pot fumigation a dense column of gas rises rapidly from the generator until deflected by the branches, foliage and ultimately the tent. The spreading of the gas through the lower part of the tree follows the forcing downward of the diffused column after

[1] South Africa Jl. Sci., v. 12, No. 3.
[2] Data obtained from the concern that liquifies hydrocyanic acid.
[3] U. S. Dept. Agr. Bur. Ent. Bull. No. 79, p. 58.



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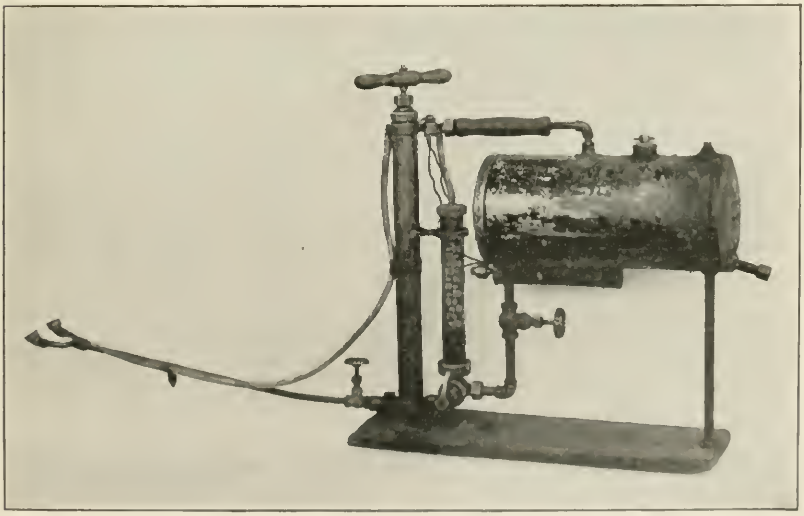

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Machines for Applying Liquid Hyrdocyanic Acid in Field Fumigation; 1, Plunger type used almost exclusively during 1918; 2, Gravity type used during 1917 and to a limited extent during 1918.

contact with the tent top. This initial condition would point to the top of the tent receiving maximum gas distribution sooner than the bottom. Furthermore, the effect of the rise of gas would tend to cause a greater concentration toward the top, although in a non-gas-tight enclosure such as a tented tree, various factors, as yet little understood, are constantly exerting important influences, changes in which must alter the movement of the gas particles to no little extent. The diffusion through the tenting is most important and unquestionably is modified by such factors as texture, its condition as to moisture, chemical treatment and accumulation of dirt particles. Furthermore, atmospheric conditions during the exposure have been proven to influence scale-kill, thus probably affecting tent leakage. Factors acting wholly within the tent, yet believed to affect gas concentration to some extent are absorption and adsorption of the foliage and the physical condition of the soil.

The violence of the reaction in an open generating vessel affects the denseness and velocity of the rising column of hydrocyanic acid gas. When the reaction is rapid the initial maximum gas concentration must needs follow more quickly than when the generation takes place over a protracted period. Furthermore, consideration of the fact that leakage occurs immediately on contact of the gas with the tent surface, injects a factor that might alter the maximum gas density attained between a slow or rapid generation. Such a view would signify a difference, possibly very slight, in pot-generated gas from potassium and sodium cyanid respectively, for solid potassium cyanid produces a violent reaction practically complete within one to three minutes. Solid sodium cyanid, on the other hand, is much slower in generation and low grade material used in California to a limited extent several years ago was observed in some cases to require fully fifteen minutes for complete liberation of gas.

The gas evolved from fumigating machines is in the form of a dense cloud injected with much force at one edge of the tent along the ground. The evolution of the gas is almost instantaneous and in a different initial direction to that of pot generation. Thus the condition surrounding the concentration and distribution of this gas, in differing from that generated in vessels within the tented tree, gives grounds for possible difference in results between the two methods.

After this brief discussion of gas-distribution in pot and machine practice, let us consider liquid hydrocyanic acid. This latter is injected at the edge of the tent with a small amount of force, as a mist, which on evaporating is left with little initial momentum. The result is a gas somewhat distributed toward the bottom of the tent, having much less initial velocity than in the case of gas generated under former

methods. Furthermore, the gas from liquid hydrocyanic acid is cooled almost to the freezing point on formation and consequently is decidedly heavier than the hot machine or pot-generated product (temperature of pot-generated gas is 100° to 153° in accordance with dosage).[1]

Since the molecular activitiy of gases increases proportionately as the temperature, it is evident that we have a very differently acting product in the new than in the old practice. The molecular activity of gas from liquid hydrocyanic acid is least when first generated but increases as it attains the temperature of the air, while in pot or machine generated gas quite the inverse is true, the initial molecular velocity of these being the greatest and decreasing as the gas cools to the lower air temperature. Thus it is evident that initial diffusion would be slower in the case of liquid hydrocyanic acid, and attained throughout the bottom of the tent sooner than the top. Differences in diffusion and molecular activity would signify a difference in tent leakage between the generated and atomized gas and that such takes place under field condition is readily detectable by careful observation.

The destruction of scale pests on citrus trees is proportional to gas concentration and hydrocyanic acid gas being lighter than air, it is natural to presume that the greatest density, signifying the best scale-kill, is toward the top of the tent. This presumption has been supported by the observation of practical fumigators and the experiments of investigators, of whom one of the first to give definite proof in support of this condition was Morrill[2] in 1908, working in Florida with the citrus white fly, *Dialeurodes citri*. More recently Quayle[3] conducted tests under tent forms with the Bean Weevil (*Acanthoscelides obtectus*) and the Granary Weevil (*Calandra granaria*) arriving at the same general conclusion, that the highest mortality is toward the top of the tent. Quayle, however, concluded that the percentage killed in the case of a tall tree is better toward the center than the top, a conclusion not in keeping with the data presented.

The writer has been conducting an investigation of the use of liquid hydrocyanic acid with special reference to dosage requirements and during the past season has closely followed the fumigation of more than 500 acres of citrus trees. It was felt that the difference in physical properties between gas obtained from liquid and field-generated hydrocyanic acid is sufficient to demand a careful revision of the dosage schedule originally prepared for pot-generated gas, but subsequently also adopted for machine and liquid hydrocyanic acid fumigation.

Accordingly gas diffusion was one of the first problems taken up,

[1] U. S. Dept. Agr. Bur. Ent. Bull. 79, p. 37.
[2] U. S. Dept. Agr. Bur. Ent. Bull. 76, p. 51.
[3] Jr. Econ. Ent. 11, 3, 1918.

the determination of which was undertaken entomologically by obtaining data on scale-kill in different parts of tented trees. The results are in part herewith presented:

Table I

Table showing the mortality of purple scale (*Lepidosaphes beckii*) at different heights above the ground on trees fumigated with liquid hydrocyanic acid. The females were largely in the egg stage and each adult with its egg quota was considered a unit:

Tree No.	Height Above Ground					
	1–2 Feet		3–4 Feet		8–11 Feet	
	Total Insects Examined	Per Cent Living	Total Insects Examined	Per Cent Living	Total Insects Examined	Per Cent Living
1	434	3.4	280	2.63	300	8.1
2	...	..	400	6.84	300	8.77
3	300	2.8	...	....	451	5.14
4	300	3.16	...	....	300	4.91
5	145	5.84	276	2.67	439	10.79
6	173	3.00	600	1.93	599	9.47
7	100	3.2	300	1.4	300	15.1
Total per cent living		3.41		3.12		8.85

Dosage—Approximately schedule ¾ for sodium cyanid.
Exposure—85 minutes.
Temperature—70°.
Inspectors—R. S. Woglum, M. B. Rounds.

The results of this experiment show that in each of the seven trees, the scale-kill was more effective toward the bottom of the tree than toward the top. Out of a total of 1452 insects at 1 to 2 feet for all the trees, 3.4 per cent were living while at 8 to 11 feet, 8.85 per cent of the 2689 examined were alive. Thus the percentage of living insects toward the top of the trees in these tests is noticeably greater than towards the bottom, which would indicate that the difference in gas density is proportionally pronounced.

Table II

Table showing the mortality of red scale (*Chrysomphalus aurantii*) at different heights from the ground on small trees fumigated with liquid hydrocyanic acid. Totals of six trees:

Height Above Ground	Total Insects Examined	Per Cent Living
1 ft.	1622	1.46
2 "	897	3.06
3 "	2162	10.29
4 "	1346	12.07
5 "	727	11.17
6 "	219	11.99

Dosage—Approximately schedule I for sodium cyanid.
Exposure—1 hour.
Temperature—66°.
Inspectors—R. S. Woglum, M. B. Rounds.

The results of these two experiments demonstrate that the scale-kill with liquid hydrocyanic acid as at present used is decidedly better toward the lower part of the tent than toward the top. This result was plainly shown in each of the trees which comprised these tests as well as in the totals. Scale-infested units within a few inches of the ground showed a higher mortality than units in the tops of tall trees.

Table III

A comparison of these results as summarized in Table I with those obtained by Morrill[1] and Quayle[2] for gas generated in pots is both interesting and instructive:

Part of Tent	Percentage of Insects Killed at Different Heights Above Ground		
	Liquid HCN (*a*)	Pot Generated Gas	
		Morrill (*b*)	Quayle (*c*)
Top	91.15%	71%	65.6%
Bottom	96.59	64	38.8

(*a*) Average percentage of 7 trees with purple scale.
(*b*) Average percentage of 6 experiments with citrus white fly on large trees.
(*c*) Results of 121 experiments with the bean and granary weevils under tent form about 12 feet tall.

The conclusion reached by both Morrill and Quayle for pot-generated gas is that the killing effect is decidedly better toward the top of the tree than the bottom.

A striking difference between these results and those with liquid hydrocyanic acid is shown, the mortality with the latter being decidedly the greatest toward the bottom of the tent. In fact, the percentage of mortality for liquid hydrocyanic acid in favor of the bottom of the tent is almost inversely proportionate to Morrill's results with pot fumigation for the top. It should be noted that the experiments with liquid

[1] U. S. Dept. Agr. Bur. Ent. Bull. 76, p 51.
[2] Jr. Econ. Ent. 11, 3, 1918.

hydrocyanic acid were carried on at comparatively high temperatures. Fumigation at very low temperatures would tend to develop even greater differences in scale-kill at various distances from the ground.

This greater density of gas toward the bottom of the tent with corresponding increased efficiency will necessitate changes in the present dosage schedule based on pot generation. A dosage schedule for liquid hydrocyanic acid is now being prepared and will be ready for the coming season's work.

The question naturally arises, in view of the difference in distribution between gas from liquid hydrocyanic acid and the other methods of generation, as to any advantage or disadvantage therefrom in the use of this recent introduction. The infestation of scale insects on large citrus fruit trees is usually most severe on the lower or most protected part of the tree; especially is this true of the purple scale. The greater killing effect of liquid hydrocyanic acid at that part of the tree most severely infested with scale is the ideal to be sought, and at once brings this gas into favor over the field-generated product for citrus tree fumigation.

There are other advantages favoring liquid hydrocyanic acid, which in themselves indicate that this new method will displace all others. The expenses of an outfit are reduced by doing away with cumbersome apparatus such as pots, generating machines, sulphuric acid drums and boxes of cyanid. The cost of tent mending is almost entirely done away with as liquid hydrocyanic acid is harmless to cloth. The treatment of small trees, frequently with such poor results in the past, can be performed with greater accuracy and corresponding certainty of results. Greater speed in tree treatment can be attained than previously and it appears possible that the quantity of hydrocyanic acid required for scale-kill can be slightly reduced over that formerly required.

However, improvement in manufacture so as to furnish a uniformly high grade product free of impurities that might start decomposition, improvements in containers through the use of a material free from chemical action with the gas, and improvement in the field application to guarantee accurate delivery and complete gasification of the required charge are necessary before this gas is placed on the high plane demanded for orchard fumigation in California. Assurance has been given that these faults will be corrected in the immediate future, in which case by the end of another year the hundred outfits using this gas are certain to be greatly augmented for time to come, or at least until some scientist discovers a method of scale control its superior.

(*End of proceedings, to be continued.*)

Scientific Notes

European Corn Borer (*Pyrausta nubilalis* Hubn.). This notorious insect has been found in the vicinity of Schenectady, N. Y., over an area of approximately 400 square miles with the probability that subsequent scouting will extend the infested territory somewhat. The most significant feature is the occurrence of the insect on the Mohawk River flats, ground annually flooded to a depth of ten feet or more with a consequent probability of the pest being swept down the river to New York City or beyond. The infestation is probably of two years' standing and is decidedly less severe than that in the vicinity of Boston, Mass.

We have obtained the best results searching for this insect by examining sweet-corn stalks, specially those which have been worked over by cattle and stripped of leaves, for a circular entrance less than one eighth of an inch in diameter and usually showing a little discoloration on the margins. In a sparse infestation there may be also a few holes through the husks and very seldom injury to the ear. The entrance holes lead into a gallery and there may be a somewhat restricted boring or a larger one which, if it extends to the node, expands irregularly and frequently has somewhat blackened walls. Most of the insect's work is within three feet of the ground and usually in stalks more than one fourth of an inch in diameter. The yellowish grey caterpillar is about three fourths of an inch long, brown headed, minutely brown spotted and with a somewhat peculiar transverse suranal plate which is angulate laterally.

E. P. Felt.

Gracillaria zachrysa Meyr., Corrective Note. In the December, 1918, issue of the Journal of Economic Entomology (page 482), reference is made to *Gracillaria zachrysa* as a pest of apple foliage in northwestern India, especially for the reason that *G. azaleæ*, which was considered an identical species, had recently been introduced into the United States.

Under date of November 23, Mr. T. Bainbrigge Fletcher states that he is in receipt of an additional communication from Mr. Meyrick to the effect that *G. azaleæ* Busck is not identical with *G. zachrysa* Meyr.

Entomologists will therefore be interested to know that the species *G. azaleæ* is not to be feared as an apple pest in the United States.

L. O. Howard.

The Toad as an Enemy of the Chinch Bug. In connection with the interesting paper in the October, 1918, number of the Journal on the "Insect Enemies of the Chinch Bugs," by W. P. Flint, it might be of interest to note that the common toad (*Bufo lentiginosus americanus*) is an efficient enemy of this insect in Kansas. Garman (Ky. Agr. Exp. Sta. Bull. 91, pp. 60–68) reports finding six bugs in the stomach of one toad out of twenty examined. During the summer of 1913 the writer examined the stomach contents of five toads taken in wheat and cornfields and found the bodies or body fragments of chinch bugs in all of them. A toad, caught in a wheat field May 6, contained the bodies of 162 bugs, while a toad found in a wheat field the evening of June 5 had just eaten 12 bugs. In the latter case, feeding had apparently just begun, as the stomach was practically empty. Three toads taken in cornfields during July contained many legs, wings, and other fragments of chinch bugs, but it was impossible to determine the number eaten.

James W. McColloch, *Associate Entomologist,*
Kansas Agricultural Experiment Station.

JOURNAL OF ECONOMIC ENTOMOLOGY

OFFICIAL ORGAN AMERICAN ASSOCIATION OF ECONOMIC ENTOMOLOGISTS

FEBRUARY, 1919

The editors will thankfully receive news items and other matter likely to be of interest to subscribers. Papers will be published, so far as possible, in the order of reception. All extended contributions, at least, should be in the hands of the editor the first of the month preceding publication. Contributors are requested to supply electrotypes for the larger illustrations so far as possible. Photoengravings may be obtained by authors at cost. The receipt of all papers will be acknowledged.—Eds.

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The Honor Roll, prepared by the Secretary of the Association, is another indication of the respect gladly rendered to the men who have heard the call and taken their places with the fighting forces of the nation. Some, unfortunately, will never return.

Without detracting in the slightest from the high credit due these men, we call attention also to the war activities of other members of the Association. Some have laid aside their professional duties to devote themselves in whole or in part to special work. A notable case is that of Prof. V. L. Kellogg, widely known because of the conspicuous services he rendered, first on the Belgian Relief Commission and later with the National Food Administration—both vitally important. The war greatly stimulated interest in insects and sanitation and amply vindicated the foresighted investigations along this line begun by Dr. L. O. Howard some twenty years ago. We should also mention, in this connection, Dr. C. Gordon Hewitt of Canada. Both have rendered most valuable service along these lines and have enjoyed hearty and fruitful support from numerous associates and followers, some rendering conspicuous aid in solving important problems in medical entomology and sanitation. Practically every American entomologist has found a greatly increased field of usefulness by applying his special knowledge to the better solution of sanitary problems, the growing of larger crops and a material increase in the vitally essential animal products. They were all necessary to win the war. We rejoice that all members of the Association have recognized the call of duty and have "carried on" in a beautiful spirit of fellowship and service.

HONOR ROLL

Allen, H. W.—Sanitary Corps, U. S. Army
Bailey, J. W.—U. S. Navy
Barber, George W.—Lieut. U. S. Army
Becker, George G.—U. S. Army
Bower, L. J.—U. S. Army
Bradley,[1] J. W.—Lieut. Aviation Branch, U. S. Army
Cartwright, William B.—Signal Corps, U. S. Army
Cotton, R. T.—Lieut. U. S. Army
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Hargreaves, Ernest—Sanitary Section, British Army
Hasey,[2] W. H.—Lieut. U. S. Army
Herms, W. B.—Capt. Sanitary Corps, U. S. Army
Hood, J. D.—Capt. U. S. Army
Howard, N. F.—Lieut. U. S. Army
Jennings,[3] A. H.—Lieut. Sanitary Corps, U. S. Army
Jones, Charles R.—Acting Major, Officers Training Corps, U. S. Army
Jones, Edward R.—U. S. Army
King, J. L.—U. S. Navy
King,[4] Vernon,—Lieut. Aviation Section, British Army
Knight, H. H.—Lieut. U. S. Army
Larrimer, W. H.—Lieut. U. S. Army
Lathrop, F. H.—Lieut. U. S. Army
Mason, A. C.—U. S. Army
Mason, S. L.—Lieut. Aviation Branch, U. S. Army
McDonough, F. L.—U. S. Army

[1] Died as a result of aeroplane accident, July 4, 1918.
[2] Killed in action in France.
[3] Killed in France.
[4] Died as result of accident.

Osborn, H. T.—Capt. U. S. Army
Parker, H. L.—Lieut. U. S. Army
Pemberton, C. E.—U. S. Army
Rosewall, O. W.—U. S. Army
Safro, V. I.—Lieut. Aviation Branch, U. S. Army
Scott, E. W.—Lieut. U. S. Army
Seamans, H. L.—U. S. Army
Snow, S. J.—Veterinary Corps, U. S. Army
Stear, J. R.—U. S. Army
Stockwell, C. W.—Aviation Branch, U. S. Army
Strand, A. L.—U. S. Army
Strickland, E. H.—Lieut. British Army
Summers, J. N.—Lieut. Tank Corps, U. S. Army
Swain, A. F.—U. S. Army
Van Dine, D. L.—Capt. Sanitary Corps, U. S. Army
Vickery, R. K.—Sanitary Corps, U. S. Army
Weigel, C. A.—Sanitary Corps, U. S. Army
White, W. H.—Lieut. U. S. Army
Whitemarsh, R. D.—Capt. U. S. Army
Wiltberger, P. B.—Sanitary Corps, U. S. Army
Wolcott, G. N.—U. S. Army
Woods, W. C.—U. S. Army

BOOK REVIEWS

Manual of Vegetable-Garden Insects, by CYRUS RICHARD CROSBY and MORTIMER D. LEONARD. The Macmillan Company, New York. Price, $2.50.

For the past decade the only American book devoted exclusively to insects attacking vegetable crops has been Dr. Chittenden's "Insects Injurious to Vegetables." Now we have another volume, with information brought forward to date, and many new illustrations. This is a volume of 391 pages, and 232 figures. Some of the illustrations are from photographs, but a large proportion are from drawings made expressly for this book. Most of them are good. The subject matter is arranged in the following order: Insects Injurious to Cabbage and Related Crops; Pea and Bean Insects; Beet and Spinach Insects; Insects Injurious to Cucumber, Squash and Melon; Potato Insects; Tomato Insects; Egg-plant Insects; Insects Injurious to Carrot, Celery, Parsnip and Related Crops; Asparagus Insects; Corn Insects; Sweet-Potato Insects; Onion Insects; Insects Injurious to Minor Vegetable Crops; Cutworms and Army-worms; Blister Beetles; Flea-beetles; Unclassified Pests; Insects and Insecticides. The last chapter contains about seven pages devoted to the structure of insects. Under the headings Cutworms, Blister-beetles, and Flea-beetles, each species is treated separately. A few references to literature follow the account of each insect. The volume is supplied with table of contents and index, and from the printer's standpoint is attractive. Though some entomologists might prefer to group potato, tomato and egg-plant insects under one heading, or place the chapter on the structure of insects and insecticides at the beginning rather than at the end of the book, the present arrangement does not in any way interfere with the usefulness of the volume which must be granted a place on the shelves of the working entomologist, the vegetable grower, and the teacher of horticulture. It goes without saying that it should be placed in every important public library as well. (*Advt.*)

W. E. B.

Practical Queen Rearing, by FRANK C. PELLETT, American Bee Journal, Hamilton, Ill.

This small volume contains 103 pages and 40 illustrations, most of them half tones, is printed on supercalendared paper, and is provided with table of contents but no index. The scarcity of certain kinds of foods and especially sugar with the high prices prevailing during the war has been an important inducement to keep bees. In connection with beekeeping there is such a demand for good queens that the average beekeeper cannot supply it. Consequently queen-rearing specialists have appeared, and the present volume is a guide for those who wish to make a nice little business by rearing queens. Mr. Pellett is a man of experience, having formerly occupied the position of State Apiarist of Iowa, and is author of "Productive Beekeeping," Mr. Pellett is also author of "Our Backdoor Neighbors," and is now associate editor of the *American Bee Journal*. He has had an extensive experience in things apicultural, and though it is characteristic of beekeepers that they do not agree on methods or equipment, it is evident that this little book will prove useful to all who contemplate the rearing of queen bees for the home apiary or for sale. (*Advt.*)

W. E. B.

Injurious Insects and Useful Birds: Successful Control of Farm Pests, by F. L. Washburn, pages I to XVIII, + 1 to 453, 414 text illustrations and four colored plates. J. B. Lippincott Company, Philadephia, 1918.

This, one of the Lippincott Farm Manuals, might properly be classed as a farm zoölogy largely and properly devoted to insects, since their importance is certainly commensurate with the space assigned. The author has endeavored to supply the needs of high schools where agriculture is taught and of agricultural colleges which demand a good, though not too technical text-book embracing a wide field. The work also appeals to farmers, orchardists, vegetable growers, owners of gardens and housekeepers and in this latter respect differs from a number of entomological volumes issued during the last few years and restricted to the enemies of special crops. It is concerned with fruit pests of all kinds, including the citrus fruits, the insects affecting field crops and pasturage, vegetable gardens, house plants, shade and forest trees, those troublesome to man and in the house, attacking stock or poultry and pests in mills and elevators. The author's extensive personal experience with the last makes the chapter of special value, particularly with cereals at their present high prices.

We have noticed in this volume a very large number of insects and other animals of the United States with special reference to their economic importance. The accounts, necessarily brief, are comprehensive and in many instances the meaning of the text is made clearer by excellent illustrations. The chapter on birds and that in relation to the four-footed pests of the farm are valuable and pertinent additions. The author has realized his aim and produced a volume which should be of great service to a very wide clientele. It is an excellent text for the use of schools and colleges, a most desirable addition for many libraries and a very convenient volume for the working library of the professional entomologist (*Advt.*). E. P. F.

Current Notes

Capt. Allan H. Jennings of the Bureau of Entomology died in December, 1918.

Dr. J. G. Needham of Cornell University, Ithaca, N. Y., visited Washington and the Bureau of Entomology in October.

Lieut. E. H. Gibson, formerly of the Bureau of Entomology, has been promoted to the rank of captain in the Sanitary Corps.

Mr. C. H. Hadley, Jr., has been promoted from instructor to assistant professor of economic entomology at the Pennsylvania State College and Station.

Mr. J. W. Gilmore, Bureau of Entomology, has been granted an indefinite furlough to enter an officers' training camp. He was connected with the Southern field-crop insect investigations.

Prof. John P. Campbell, for thirty years professor of biology in the University of Georgia, died December 3, 1918. Several years ago, Professor Campbell published a number of papers on injurious insects.

The nursery stock, plant and seed quarantine, which has been discussed during the summer and fall, received the approval of the secretary of agriculture November 18, 1918, and becomes effective June 1, 1919.

According to the *Review of Applied Entomology*, Mr. F. H. Taylor of the Australian Institute of Tropical Medicine has been appointed entomologist to the Special Blow-Fly Committee of the Federal Bureau of Science and Industry at Queensland.

Mr. K. L. Cockerham of the Bureau of Entomology, who is experimenting with heat control of the sweet potato weevil in Mississippi, reports promising results from some of his recent experiments against the weevil in stored tubers.

Dr. J. C. Hutson, formerly of the Imperial Department of Agriculture, Barbadoes, British West Indies, has been appointed government entomologist of Ceylon with headquarters at the Royal Botanic Gardens, Peradeniya, Ceylon, and will soon enter upon his duties.

Mr. E. W. Scott in charge of the Vienna, Va., laboratory of the Federal Insecticide Board was granted an indefinite furlough to enter the Quartermaster's Corps of the army where he was granted a commission as first lieutenant.

Mr. George M. Anderson, formerly assistant to the state entomologist of South Carolina, has been appointed extension entomologist by the Bureau of Entomology and assigned to North Carolina, where he will carry on extension work in the whole field of economic entomology.

Mr. Irving W. Davis has been discharged from military service where he was a corporal in the U. S. Marine Corps, stationed at Paris Island, S. C. He has resumed his former work in charge of the gipsy moth field work in Connecticut, with headquarters at Danielson.

Mr. V. I. Safro has been discharged from military service, where he held a commission as second lieutenant in the Aviation Corps, and will resume his former position as entomologist for the Kentucky Tobacco Products Company, Louisville, Ky. On his return he visited a number of economic entomologists in the Eastern States.

Dr. J. M. Aldrich who has recently been attached to the West Lafayette, Ind., laboratory of the Bureau of Entomology has been transferred to Washington, D. C., to fill a vacancy on the miscellaneous roll of the Bureau caused by the death of Mr. Frederick Knab, as honorary custodian of the non-muscoid Diptera in the U. S. National Museum.

Dr. E. F. Phillips and Mr. George S. Demuth spent a large part of the months of November and December in California where they investigated the bee-keeping possibilities of the National Forest Reserves in Southern California. They then took part in the extension schools for commercial bee-keepers at San Diego, Davis, Visalia, and Riverside.

The Entomological Society of America did not hold its usual series of meetings for the reading and discussion of papers this year. Two brief sessions were held at Baltimore for the transaction of the necessary business. The following officers were elected for the coming year: President, James G. Needham; First Vice-President, James W. Folsom; Second Vice-President, R. V. Chamberlain; Secretary-Treasurer, J. M. Aldrich.

Mr. Allen B. Duckett, assistant entomologist in the Bureau of Entomology and connected with the Stored-Product Insect Investigations, died from pneumonia October 8, 1918. Mr. Duckett was a graduate of the Maryland Agricultural College, had been connected with the Bureau of Entomology for more than seven years, and at the time of his death was engaged in inspecting army stores at the port of New York.

No pink bollworm has been found in Texas this year and the Board is therefore joining with the Commissioner of Agriculture of Texas in a recommendation to the governor of that state that the growing of cotton be permitted under certain conditions within the quarantined districts. These restrictions will involve complete control of the seed for planting and of the disposition of the crop produced in the season of 1919.

George Compere, one of the efficient port inspectors of the State of California, at San Francisco, has been loaned to the Federal Horticultural Board to investigate conditions at New Orleans and possibly Mobile to determine whether or not port inspection should be inaugurated and maintained at these ports along the lines now conducted for the port of San Francisco. It is expected that Mr. Compere will spend the months of January and February in this investigation.

The following appointments in the Bureau of Entomology have been announced: Extension work in apiculture—J. V. Ormond, Arkansas, Kansas, Missouri, and Nebraska; Edward S. Provost, South Carolina; J. Smith, California. Extension work, deciduous fruit insects—George H. Miller, Albion, N. Y. Extension work, cereal and forage insects, Harvey H. Miniger, South Dakota; Karl M. Pack. Extension work in general economic entomology—George M. Anderson, North Carolina; M. B. Rounds, citrus fruits, California; E. E. Wehr. Extension work with insects affecting domestic animals—J. Touhy, assistant in body-louse investigations; Harrison E. Smith, work with European corn borer, Boston, Mass.

Resignations in the Bureau of Entomology have been announced as follows: To enter military service—Charles W. Curtin, Carolina; H. M. Fort, Missouri; Marshall Hertig, Minnesota; G. J. Hucker, Nebraska; J. M. Lowe, Texas; Max W. Reeher, Oregon; Douglas R. Royter, Texas; A. I. Fabis, Texas; H. L. Seamans, Montana; Paul Starkweather, Georgia. Twelve inspectors, Federal Horticultural Board—W. W. Decell, J. A. Dew, E. L. Diven, W. S. Hough, Herbert Lahr, M. I. Miller, E. J. O'Dowd, R. W. Reeves, Torbert Stack, J. E. Webb, C. A. Weigel, J. C. Woodward, A. Burr Black, Albert E. Booth, Mancil B. Boyd, Kenneth E. Bragdon, F. Vernon Griffith, J. G. Griffith, Montfort Hull, H. E. Jaques, H. B. Pierson, E. L. Prizer, Frazier Rogers, C. E. Trimble, G. H. Vansell, H. L. Weatherby, M. J. Kerr, Miss Mabel Connell; H. J. Ryan, California, to become horticultural commissioner of Los Angeles County, Cal.; Wm. R. Martin, Earl Ranells, J. M. Robinson, J. Howard Smith, Henry E. Bailey; Clyde C. Hamilton, to enter the State Service of Missouri; J. E. Morrison, to become a county agent in Colorado.

The following transfers have been made in the Bureau of Entomology: Oscar Barber, sweet potato weevil, Texas, to another branch; M. E. Kimsey, cereal and forage insects, Arizona, to pink bollworm work, Texas; Q. S. Lowry from extension work with truck crop insects to general economic insect extension work in Massachusetts; S. E. McClendon, headquarters, Hawkinsville, to Athens, Ga.; M. R. Smith, Plymouth, Ind., for the winter to Kingsville, Texas; M. H. Arnold, Mississippi, for the winter to Texas; F. M. Wadley, Wichita, Kans., to Muscatine, Iowa; O. K. Courtney, Maryland, truck crop insects to Federal Horticultural Board; C. E. Smith, New Orleans, La., to Texas; B. R. Leach, Bennett A. Porter, R. J. Fiske, and R. B. McKeown, deciduous fruit insects, temporarily to Federal Horticultural Board for work on pink boll worm in Texas; F. H. Gates, corn borer work to alfalfa insect investigations, Tempe, Ariz.; A. F. Satterthwait, Charleston, Mo., to Webster Groves, Mo.; L. C. Griffith, extension work, New York, to Federal Horticultural Board; Frank J. Rimoldi, extension work, Rhode Island, to Federal Horticultural Board, Texas; A. C.

Burrill, Washington, extension work to cereal and forage insect investigations; C. H. Batchelder, extension work, Maine, to truck crop insect investigations; W. T. Ham, extension work, Washington, to truck insect investigations; R. A. Epperson, Alabama, temporarily to work on the pink bollworm in Texas.

Mr. Warren Williamson has resigned as instructor in entomology and assistant entomologist at the Minnesota University and Station.

According to *Science* Dr. J. F. Abbott, professor of zoölogy at Washington University, has been appointed commercial attaché to the American Embassy at Tokyo and will leave for Japan in February.

According to the *Experiment Station Record*, the Misses Emily H. Payne, Ida R. Saul and Anna Wentz have been appointed assistants in entomology at the Minnesota University and Station to replace men who were called to military service.

According to *Science* at the annual meeting of the Brooklyn Entomological Society held on January 16, the following officers were elected for 1919: President, Mr. W. T. Bather; Vice-President, Mr. W. T. Davis; Treasurer, Mr. C. E. Olsen; Recording Secretary, Dr. J. Bequaert; Corresponding Secretary, Mr. J. R. de la Torre Bueno; Librarian, Mr. A. C. Weeks; Curator, Mr. George Frank; Publication Committee, Messrs. J. R. de la Torre Bueno, Charles Schaeffer and George Engelhardt.

According to *Science* Dr. James A. Nelson has resigned his position as expert in the Bureau of Entomology, though he will still be connected with the Bureau as collaborator, and will make his home near Mount Vernon, Ohio, where he will give his attention to farming.

Mr. R. L. Webster, formerly of the entomological department of the Iowa College and Station, is now at the entomological department of Cornell University, Ithaca, N. Y., where he holds an industrial fellowship, and is working on the practicability of fumigation of deciduous fruit trees with hydrocyanic acid gas.

Mr. Frank D. Heckathorn, deputy inspector, Bureau of Horticulture, Department of Agriculture of Ohio, died December 18 after a short illness with influenza. He was graduated from the Ohio State University in 1906. Mr. Heckathorn was a careful, conscientious worker who gained the respect of everyone with whom he came in contact.

European corn borer conferences have been numerous since the discovery of this pest in New York State. The first was held at Albany, February 7, and was attended by three representatives of the Federal Bureau of Entomology, and a number of New York entomologists. A second occurred at Washington, February 12th, at which time Messrs. O'Kane, Sanders, Reynolds, of the American Plant Pest Committee, and Felt conferred with the Senate Committee on Agriculture and Doctor Howard of the Bureau of Entomology. There was a third the next day at Ithaca, attended by New York entomologists and agriculturists followed by a fourth at Albany, February 18th. The outcome of recent activities and interest has been the adoption by the State of New York of an aggressive policy toward this new menace and a material increase in the amount recommended by the Secretary of Agriculture for use in control or extermination work.

Mailed February 28, 1919

EXCHANGES.

Exchanges or Wants of not over three lines will be inserted for 25 cents each to run as long as the space of this page will permit; the newer ones being added and the oldest dropped as necessary. Send all notices and cash to A. F. Burgess, Melrose Highlands, Mass., by the 15th of the month preceding publication.

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DR. W. E. HINDS,
Auburn, Alabama.

WANTED—Will pay cash for literature on ants. Publications of The American Museum of Natural History, by Dr. Wheeler, especially desired.

M. R. SMITH, 128 West 10th Ave., Columbus, Ohio.

WANTED—19th Illinois Entomological Report; Coleoptera of Southern California by H. C. Fall; Notes on Lachnosterna of Temperate North America by J. B. Smith; Complete Works of Thos. Say, Le Conte Edition.

JOE S. WADE, U. S. Bureau of Entomology, Washington, D. C.

WANTED—List of Col. of Amer. Henshaw, 1885; Col. of So. Cal., Fall; Insects of N. J. Smith, 1909; Bib. Econ. Ent. Part IV.

FOR SALE OR EXCHANGE—Bull . and Cir. U. S. Bur. Ent., State Ent. Bull. and Separates U. S. N. M. C. L. SCOTT, Wellington, Kansas.

WILL PAY $1 each for Insect Life, Vol. IV, Nos. 11 and 12, Bibliography, N. A. Economic Entomology, Part IV, or General Index Experiment Station Record for Vols. I–XII.

HUGH GLASGOW, Agricultural Experiment Station, Geneva, New York.

DRAWINGS for reproduction, oil color charts, and life history collections of economic insects prepared as desired.

H. E. HODGKISS and B. B. FULTON, 90 Lyceum St., Geneva, N. Y.

WANTED—Systematic and economic papers on the families *Bombyliidae* and *Asilidae*. Mail descriptive list of titles and prices desired. H. R. HAGAN, Utah Experiment Station, Logan, Utah.

WANTED—Syrphidae—from all parts of the world. Will determine on the usual conditions. Address until June 15, Prof. C. L. METCALF, Bussey Institution, Forest Hills, Boston, Mass. Afterward Ohio State University, Dept. Entomology, Columbus, Ohio.

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Proceedings of the Thirty-first Annual Meeting of the American Association of Economic Entomologists

(*Continued from p. 123*)

Afternoon Session, Friday, December 27, 1918, 2.40 p. m.

Vice-President E. C. Cotton: The next paper on the program is entitled, "Important Insect Pests Collected on Imported Nursery Stock, 1918," by Mr. E. R. Sasscer.

IMPORTANT FOREIGN INSECT PESTS COLLECTED ON IMPORTED NURSERY STOCK IN 1918

By E. R. Sasscer

The amount of nursery stock offered for entry into the United States during the fiscal year 1918 showed a marked decrease as compared with former years. Especially is this true of the five principal exporting European countries,[1] which showed a falling off of some 22,953,147 plants. The number of plants exported by these European countries for the fiscal year 1918 was as follows:

England	1,865,539
France	16,767,673
Holland	2,016,884
Belgium and Germany	

In other words, France alone exported more stock to the United States in 1913 than all these countries in the fiscal year 1918. A summary of the plant imports for the fiscal year ending June 30, 1918, is

[1] The amount of stock exported by these countries from 1913 to 1917, inclusive, is given in previous lists of important foreign insect pests, etc., published in the Journal f Economic Entomology.

given by Mr. C. L. Marlatt, Chairman of the Federal Horticultural Board, in his report to the Secretary of Agriculture of September 30, 1918.

Notwithstanding the falling off of importations of plants, dangerous insects have continued to enter on nursery stock. As these pests are listed in the Quarterly Letters of Information of the Federal Horticultural Board, copies of which are available to all inspectors, it is only necessary to refer to the insects which appear to have potentialities, if they become established and widely distributed in this country.

The pink bollworm (*Pectinophora gossypiella* Saunders) has been collected on two occasions in shipments of cotton from Brazil. In one instance, some 1,992 bags of cotton arrived at New York in violation of the cotton regulations, and, as a result, were returned to the port of origin, where, according to the Department of State, the entire shipment was destroyed by the Brazilian Government, on account of this infestation. The second shipment, consisting of about a pound of infested cotton seed, was sent to the Department of Agriculture, and, after a thorough examination, destroyed by fire. The sorrel cutworm (*Acronycta rumicis* L.), which was referred to in the last list of important foreign insect pests, has again been collected, in the pupal stage, on miscellaneous plants from France. From European literature, it is apparent that this insect is an omnivorous feeder, and its entry into and establishment in this country should be prevented, if possible.

A shipment of rhododendrons from Holland was found to be lightly infested with larvæ of *Chimabacche fagella* Fab., an insect reported to be injurious to the foliage of oak, beech, and birch in northern and eastern Ireland. Judging from the available literature on this insect, it is apparent that it is primarily a forest and shade-tree pest, and its occurrence on rhododendrons may possibly be accidental; although at the time of examination there was abundant evidence of foliage injury. The larvæ of the swan or gold-tail moth (*Porthesia similis* Fuessl) were collected on Japanese maple from Holland and on *Cerasus avium* from France consigned to Pennsylvania. One hundred and ninety-four nests of the fruit-tree Pierid (*Aporia cratægi* L.) were collected by New York state inspectors on several shipments of deciduous fruit tree seedlings from France. The fruit tree Pierid is another European insect which is known to be a general feeder, having thus far been recorded as devouring the foliage of fruit trees, wild rosaceous plants, and deciduous shade trees.

The azalea leaf miner (*Gracilaria zachrysa* Mey.) has been taken on eight shipments of azaleas from Holland. Nests of the brown-tail moth (*Euproctis chrysorrhœa* Linn.) were collected on ten shipments of miscellaneous plants from France, and egg masses of the gipsy

moth (*Porthetria dispar* Linn.) were taken on two shipments of French stock.

The lesser bulb fly (*Eumerus strigatus* Fallen), together with the narcissus fly (*Merodon equestris* Fab.), was collected in considerable numbers in narcissus bulbs from Holland. The lesser bulb fly was also submitted for identification by one of the seed firms of Philadelphia, with a note that the larvæ were taken from Holland-grown narcissus bulbs. This bulb insect is known to be established in the states of California, Washington, Colorado, Ohio and Maine. Although the economic status of the lesser bulb fly is in dispute, Verrall[1] says the European *E. strigatus* has been bred from bulbs of the common onion (*Allium cepa*) of which they sometimes destroy a whole crop.

Seeds of the wild cherry (*Cerasus avium*) from France were found to contain a number of dead adults of *Anthonomus rectirostris* L.[2] This weevil in Europe is known to feed in the pits of Prunus and Cerasus. Inasmuch as tons of cherry and Prunus seeds have been introduced into the United States in the past, a large percentage of which were never inspected or fumigated, it is remarkable that this insect has not been introduced into and established in the States. Of course, there is a possibility that it is established in isolated localities and has not been recorded. Sugar-cane entering California from the Hawaiian Islands was found to be infested with the sugar-cane borer (*Sphenophorus obscurus* Boisd.). Avocado seeds from Guatemala have continued to arrive infested with larvæ of an undescribed species of Conotrachelus and an unrecognized Stenoma. The larvæ of both of these insects are responsible for considerable injury to the seed, and, according to Mr. Wilson Popenoe, who has spent considerable time collecting these seeds in Guatemala, this lepidopterous insect is perhaps one of the most injurious avocado pests now established in Central America.

As usual, a number of scale insects have been intercepted on incoming stock; the more important ones being an undescribed species of Solenococcus on avocado cuttings from Guatemala, the European peach scale (*Lecanium persicæ* Fab.) on Fontanesia and *Berberis purpurea* from France and on peach from England, *Parlatoria chinensis* Marlatt on two species of Pyrus from China, and *Lecanium coryli* Linn. on an undetermined host from England.

Vice-President E. C. Cotton: Is there any discussion of this paper?

Mr. R. C. Osburn: Mr. Chairman, I should like to report the occurrence of *Eumerus strigatus*, the bulb fly, at Columbus, Ohio, last

[1] *British Flies*, Vol. 8, p. 615, 1901.

[2] According to Dr. W. Dwight Pierce, *A. druparum* L. is a synonym of *A. rectirostris* L.

spring. I tried to trace up the origin of these, thinking that if they came from the onion I would certainly be able to follow up the scent, but I was not able to find where they came from. However, I hope they have not located there permanently.

Vice-President E. C. Cotton: The next paper is "Organization for Insect Suppression," by Mr. A. F. Burgess.

ORGANIZATION FOR INSECT SUPPRESSION

By A. F. Burgess, *Melrose Highlands, Mass.*

With the reconstruction and rearrangement of activities which must necessarily accompany the period immediately following the Great War, it seems timely to consider briefly what methods and organizations have proved workable and satisfactory when applied on a large scale. It is not the purpose of this paper to deal with insect suppression which may be handled along the lines of extension work, although it is possible that some of the ideas conveyed may be applied directly to the management of these activities.

For over twenty years the entomologists of the United States have been face to face with serious insect problems. Some have been local while others were general in their scope. During the first part of this period little organization seemed necessary, as the workers were few in number and the importance of the problems was not brought home to the public and emphasized enough so that their full meaning was appreciated.

Twenty years ago the Jersey mosquito was a standing joke. It was considered by the public as one of those nuisances that must be endured and very few entomologists were courageous enough to boldly advocate exterminative measures on a large scale. Careful investigations of the habits of the mosquito family brought to light the serious menace of permitting these insects to continue their increase unchecked, and today public opinion recognizes that they are not only obnoxious on account of their irritating habits but that some of the species are positively dangerous because of their ability to spread disease. The same is true of many other insects which annoy and make life uncomfortable for man and beast.

It cannot be claimed that control measures have been put into operation, except possibly over limited areas, that have completely relieved this undesirable condition; but when we compare present conditions with the apparent hopelessness of the situation twenty years ago, we must conclude that progress has been made.

No insect, up to the present time, has caused such widespread con-

sternation among the fruit-growing interests as the San José Scale, and as a result of its introduction and spread throughout the nation, practically every state has passed laws relating to its control as well as that of other serious pests. It is not an item of news to the members of this association to call attention to the diversity of laws, of regulations and of forms of organizing the work which resulted from the danger of the unrestricted spread of this insect. Repeated attempts were made to secure Federal legislation in order that problems of controlling dangerous pests might be handled with more uniformity, but these attempts failed until the Plant Quarantine Act was passed by Congress in the summer of 1912. Since that time attempts have been made to secure uniform state legislation, but so far as is known to the writer, little success has resulted along this line. Inasmuch as proper organization of work of this character usually is based on State or Federal law, careful attention should be given to have the statutes carefully drawn.

Never within the memory of the present generation has the food situation been so pressing as during the past two years, or have the people been obliged to conserve their resources so extensively, and never has there been a time when National and State indebtedness has mounted so high. This is bound to have a direct influence on future taxation and future prosperity. It would therefore seem fitting for the entomologists to place their houses in order against the time when retrenchment will be the order of the day, and reconstruct and regroup their activities so as to secure maximum results.

Insect suppression naturally falls into two classes, viz: The control of insects that are widely distributed throughout the country and control of newly established pests which are present in a limited area.

The methods used in the former class must necessarily be suited to the local conditions and in many cases they cannot be standardized, and the form of successful organizations for carrying on the work must be adapted to these conditions. Better results might be obtained, however, by closer acquaintance of the officials engaged in the work and a more thorough understanding of the problems and difficulties with which each has to contend. Meetings like this should pay large dividends in increasing efficiency if all could attend, but many of the authorities concerned do not take steps to make this possible.

This will not accomplish all that should be undertaken. There should be closer relations established between the State and Federal authorities that are mutually interested in these matters and a constant effort should be made to strengthen these relations. Spasmodic efforts for improvement are not likely to be successful and if this work is to be left to individuals who are already overburdened with other

duties, or to committees who have neither the time nor wide knowledge of the conditions that exist throughout the country, little of permanent value is likely to result.

Some office in the Bureau of Entomology or in the Federal Horticultural Board should make a special study of these matters and after becoming acquainted with all the details of the problem should make an attempt to bring about better conditions. It is needless to say that such a task calls for experience, skill, and the utmost tact, and that improvement along these lines cannot be hastened by using a club. Perhaps a committee of this association could coöperate to advantage along these lines.

In the control of introduced pests the problem is quite different. During recent years the Federal Government has recognized its responsibility in this direction and an increasing amount of work is being done.

The control or extermination of introduced pests present many difficult problems. In the first place the insect must be of great economic importance and the necessity for active work must be well recognized if it is to gain public support. It is impossible to accomplish results unless adequate funds are provided. If a skyscraper is to be constructed the judgment of the architect is respected or he drops the job. You cannot build a $10,000 house for $2,000 and few people have the hardihood to attempt it. Yet it is not uncommon to see an entomologist attempting to solve far more intricate and difficult problems in insect suppression with financial support which he and every one else knows is inadequate. He tries to build the $10,000 house and if perchance he is fortunate enough to lay the foundation with the funds at his disposal, he congratulates himself that something has been accomplished, excuses the incompleteness of the work as best he can and endeavors to secure more support in order to add another instalment to the structure before the ravages of time undo the work that has already been done.

The results of this method are far-reaching. Because of inadequate funds and superabundance of work, it is impossible to give the close study to all the details which are necessary if the best results are to be secured. There is also the tendency to secure quantity rather than quality when assistants are employed and this must often be done because the funds are not available for a sufficient number of the best experts. Under present conditions there is small inducement for young men to specialize in entomology. When the expert can secure little more than the untrained laborer, men of ability will naturally seek those fields of employment where fair pay and the reasonable comforts of life can be secured. If the most competent men are to be obtained to

attempt the difficult and perplexing problems of insect suppression, compensation commensurate with the importance of the tasks must be forthcoming.

The strongest and most effective organizations in this country recognize these facts and act accordingly.

On the other hand, unsatisfactory results may be secured when ample funds are provided if care is not taken in properly organizing and directing the work. Experience, skill and good judgment are required to bring about the desired results and if these are lacking disappointment will follow.

Plainly stated, the essential features of any problem of this sort are to determine all the facts covering the life and habits of the insect concerned, the kind of food that it requires, the damage likely to result, the means of spread, the effectiveness of natural agencies, and the best field treatment to bring about its control.

These may be grouped under the head of experimental work, the most important phases of which should be given the greatest prominence; field work to determine the territory that is infested and to apply new control measures and quarantine to prevent the spread of the species by inspection, fumigation or otherwise.

Each of these phases of the work should be organized and the details of methods worked out to fit the problem at hand. This will prevent duplication of effort and make it possible to transfer men to projects where they are most needed. If the problem is a large one this can be accomplished by centralizing the control of the work, so that overlapping can be avoided, misunderstandings be quickly adjusted and arrangements made with the State Officials and other agencies in touch with the work.

Five years' experience with the method of organization indicated above, which was adopted for handling the gipsy moth work by the Bureau of Entomology, has demonstrated its value. On such a large problem where 200 or 300 men are employed and work is often carried on in several states at the same time, centralization is imperative if the best results are to be secured. Where a large force is employed, a system of reports and constant field supervision is essential if the full value of the money expended is to be realized. A plan along the same general lines is practical on a smaller scale. To illustrate the usefulness of this method a few cases may be cited. Several years ago it seemed desirable to determine whether the introduced parasites of the gipsy moth were attacking native injurious insects. Experimental work had shown that some of these parasites passed through their spring generation on the gipsy moth but it was necessary for them to have a summer or fall host, otherwise the later broods of the parasites

would perish. Accordingly a plan was made to secure collections of native lepidopterous larvæ each summer from as many localities within the gipsy moth infested area as possible. The necessary instructions concerning the kinds of collections desired, and the information to be recorded by each collector was sent to each foreman and inspector throughout the territory and some of the State officials were interested to forward material. This arrangement was worked out in detail. The men were supplied with shipping boxes and mailing tubes and these containers were promptly returned to them as soon as they were emptied at the laboratory. In midsummer we have frequently received by mail fifteen containers daily with this class of material alone. As a result of this opportunity to utilize the services of these men without interfering with their regular duties, a large amount of valuable data has been secured from a territory which covers about one-half the area of the New England states. Incidentally an enormous number of records of parasitism by native Hymenoptera and Diptera have been obtained and as this work is carried on year after year, the facts concerning the increase or decrease in abundance of the native insects in this region together with similar facts as to their parasites will be extremely useful.

It has been found desirable to secure accurate records of temperature and humidity from a number of selected localities for use in connection with some of the experiments. Self-recording instruments which require attention weekly have been installed and in many cases these are attended to by inspectors or foremen without interfering with their regular work.

If special information is desired from any part of the area, it can usually be obtained without delay or friction by utilizing men who are employed by some section of the work. This arrangement is valuable in saving time, effort and money, and also serves to increase the interest of the men in the work as a whole.

Perhaps it may not be out of place to add that it takes more than a system to make any organization successful. One of our ex-presidents of the United States, when addressing a class in Civil Government at Harvard University a number of years ago, stated that anyone could devise a good system of government but that it takes a smart man to make it work. Many of the best laid plans of work fail because of the ever present human element which is often the dominant factor.

Any enterprise in insect suppression cannot be successful if this fact is ignored. If men are assigned to do those things for which they are best qualified and in which they are most proficient, much will be accomplished. The misplaced man is dissatisfied both with himself and his job and is a prolific source of discontent in any institution.

The success of most problems in insect suppression work rests principally on good business management and entomologists should not be slow in recognizing this fact.

Vice-President E. C. Cotton: This completes the program of the horticultural inspectors.

In the absence of the President, I will call for the next paper,

THE MORPHOLOGY, BEHAVIOR AND SUSCEPTIBILITY OF THE EGGS OF THREE IMPORTED APPLE PLANT LICE

By Alvah Peterson, *New Brunswick, N. J.*

(Withdrawn for publication elsewhere)

Vice-President E. C. Cotton: The paper is open for discussion now.

Mr. P. J. Parrott: As I understand the speaker, you make the application of lime sulphur solely to destroy the eggs.

Mr. Alvah Peterson: No, because at that period the eggs are hatching and the combination will kill the nymphs and the eggs.

Mr. P. J. Parrott: In New York we are advising our farmers to hold back the spraying, because we aim at the nymphs.

Mr. Alvah Peterson: In New Jersey the eggs have not all hatched at a time when we apply the material. *Aphis avenæ* in our state hatches ten days before *Aphis sorbi*. To wait until the eggs are all hatched would be too late.

Mr. C. P. Gillette: Through how long a period did you find the eggs of any one species hatching normally?

Mr. Alvah Peterson: Ten days—usually less than that. If you have a warm spell during the hatching period, they will hatch in four or five days, but if it is cold and wet the hatching period may extend over a period of ten days for one species.

Mr. P. J. Parrott: In your field experiments, when the trees have been thoroughly sprayed at the time indicated by your third picture, did you have any difficulty in getting complete killing of the insects?

Mr. Alvah Peterson: I can give you an example of that in one orchard where the man was very thorough in his work. We tried the nicotine combined with the lime sulphur, and even though this man was very thorough in his work, he did not get 100 per cent. Our experiments also showed that the eggs of *Aphis sorbi* and *pomi* are not as susceptible to sprays as *avenæ*.

Mr. P. J. Parrott: But you are making that recommendation?

Mr. Alvah Peterson: Yes, because it is the best recommendation we have, so far as we know at the present time.

Mr. W. J. Schoene: The hatching of these eggs and the appearance of the aphids have been noted for several past seasons, not only by the entomologists but also members of the other departments. The fact has been noticed that the eggs hatch many weeks in advance of the time when the buds show green at the tips. We found them late in February and early in March, when the aphid had no chance to obtain food.

Mr. Alvah Peterson: What species?

Mr. W. J. Schoene: *Avenæ.*

Mr. R. C. Osburn: I would like to ask Dr. Peterson whether his observations indicate that *avenæ* is of any importance in getting out the test? What experiments have you to show that the nicotine should be used one to four hundred, as against one to nine hundred? The bulk of the United States probably uses nicotine sulphate at the rate of three quarters of a pint to one hundred gallons, and it would be very interesting to know why New Jersey reduces the recommendations to one to four hundred?

Mr. Alvah Peterson: In the first place I might say that our recommendation is one to five hundred.

In respect to the difference in the amount of injury done by the various species, of course that which is done by the *avenæ* is least of all. I fully expect to see injury done by *avenæ* this coming spring for they undoubtedly will be abundant, because I know of one orchard today in New Jersey where the eggs are actually so abundant that you cannot touch a square inch of the large trunk of the tree without crushing a number of eggs. When these eggs hatch and come out and attack the young, green buds, it stands to reason that there will be some injury, even though it may not be as marked as that of *sorbi* or *pomi.*

In respect to one to five hundred or one to a thousand, or whatever might be recommended in using nicotine sulphate, I might say that we do not get as good a clean-up with one to a thousand as we do with one to five hundred. Mr. Barclay carried on experiments in his orchards with one to five hundred and one to a thousand, which showed conclusively that one to five hundred is much better. Dr. Headlee has carried out some experiments along that same line. Probably he could give you some pointers on this.

Mr. T. J. Headlee: We have been interested in the study of the control of the apple aphis for three or four years, and we were lead to take it up because of the failure of some of our orchardists to obtain protection by the application of nicotine at the cluster cup or pink bud

spray. The same year that this failure occurred we made a laboratory test to determine the minimum dosage which would destroy the rosy aphis. At the time the test was made the rosy aphis was present in all stages from the slaty colored stem mother to the winged forms. The results of that test are shown in the following table:

Effect of Nicotine Sprays on Rosy Aphis

Number of Leaves	Treatment	Percentage Living at End of Experiment
2	Water only	100
2	"Black Leaf 40" (1 part) + water (900 parts)	60
2	"Black Leaf 40" (1 part) + water (900 parts) + soap (2 lbs. to 50 gal.)	10
2	"Black Leaf 40" (1 part) + water (700 parts) + soap (2 lbs. to 50 gal.)	1
2	"Black Leaf 40" (1 part) + water (500 parts)	10
2	"Black Leaf 40" (1 part) + water (500 parts) + soap (2 lbs. to 50 gal.)	0

The following year we laid out some blocks of seven-year-old apple and made the series of treatment indicated in the following table:

Summary of Results in Aphis Control Experiment

Plot Numbers	Treatment	Total Number of Buds Examined	Total Number of Aphis Found	Number of Aphis Per 100 Buds
1 & 1	Lime-sulfur (1 to 9) during dormancy; "Black Leaf 40" (1 to 1,000) + soap (2 lbs. to 50 gal.) when buds showed green	281	5	1.7
2 & 2	Lime-sulfur (1 to 9) during dormancy; lime-sulfur (1 to 9) + "Black Leaf 40" (1 to 1,000) when buds showed green	282	18	6.3
3 & 3	Lime-sulfur (1 to 9) when the buds showed green	320	304	95
4 & 4	Lime-sulfur (1 to 9) + "Black Leaf 40" (1 to 500) when buds showed green	339	11	3.2
5 & 5	Lime-sulfur (1 to 9) + "Black Leaf 40" (1 to 1,000) when buds showed green	331	156	47.1
6 & 6	Scalecide (1 to 15) while buds were dormant	306	37	12
7 & 7	Scalecide (1 to 15) when the buds showed green	303	9	2.9

Note.—Unsprayed trees showed average of 600 aphis per 100 buds.
A large block of trees of the same age and variety in the same orchard were sprayed with lime-sulfur (1 to 9) during dormancy. These trees showed an average of 6 aphis to 100 buds.

Mr. John Barclay of Cranbury was the orchardist coöperating and the man who personally made the treatments. Throughout my entire experience I have never seen an orchardist or an entomologist who made treatments any more thoroughly than Mr. Barclay and I believe therefore that the data obtained are reliable. This table shows that the spray of winter-strength lime-sulphur to which 40 per cent nicotine was added at the rate of 1 to 1000 left fifteen times more living aphis

on the tree than the spray composed of winter-strength lime-sulphur to which 40 per cent nicotine was added at the rate of 1 to 500. No man can say without a foreknowledge of the weather what degree of reduction will constitute a control. It is therefore advisable to obtain the greatest degree of reduction possible, and the mixture of winter-strength lime-sulphur to which 40 per cent nicotine has been added at the rate of 1 to 500 appears to give a much greater reduction than the less strengths of nicotine.

President E. D. Ball: I will now call for the next paper by Mr. A. L. Quaintance.

Mr. A. L. Quaintance: I wish to explain that I prepared no paper. When I saw that there were already on the program papers dealing with the Japanese beetle and oriental fruit moth, it appeared to me preferable to discuss and perhaps elaborate on the papers presented, if opportunity offered, rather than to present another formal paper. Unfortunately I missed hearing the papers presented by Professor Cory and Mr. Goodwin, but have no doubt that the subjects were fully covered.

There are two or three questions relative to quarantine measures, however, and the question of possibility of the eradication which may be of interest to some of the membership. The quarantine question is, of course, in the hands of the state entomologists concerned. As to the eradication of the oriental fruit moth and Japanese beetle, I would say that in my opinion while such eradication is of course within the realms of possibility, provided large funds are available and very drastic measures are adopted, yet I doubt the feasibility and expediency of a program of this character.

Perhaps all of these questions have been discussed by Mr. Goodwin and Professor Cory and I would not wish to repeat anything since we have still before us a very interesting program. It is suggested therefore that unless there are particular questions in which members are interested that further time be not taken up with this subject.

Mr. P. J. Parrott: We people from other parts of the country do not often have the opportunity of seeing Mr. Quaintance, much less to hear him, and I would like very much to have him discuss both of these insects and give us his impression of the situation.

Mr. A. L. Quaintance: Referring first to the Japanese beetle: We do not know, of course, how much of a pest the Japanese beetle is going to be. While the adults attack a large variety of food plants, some of which are injured to an important extent, it is very probable that such damage can be effectively checked by the use of arsenical poisons sprayed or dusted over the plants being injured. The beetles feed upon numerous ornamentals which are now, as a rule, but little sprayed, but which for the most part could readily be sprayed without

unduly complicating their profitable cultivation. We are quite uncertain as to the amount of damage to expect from the larvæ attacking the live roots of plants. This type of injury, if important, would probably prove difficult of correction.

I think entomologists are warranted in assuming that a newly introduced insect will become a troublesome pest and arrange their work on that basis. A change of policy, of course, can be adopted as soon as it is clear that the insect in question will not be especially troublesome. Acting on this plan the Bureau of Entomology, coöperating with Dr. T. J. Headlee, New Jersey State Entomologist, has undertaken work looking toward the eradication and control of the insect. Mr. Goodwin doubtless fully explained to you this morning the character of field work now under way. If its eradication cannot be accomplished, our efforts, it is hoped, will result in restricting its spread until its economic status will have been better determined.

Our inspection records for 1917 of the distribution of the Japanese beetle were not very extensive, and while we have been able to make fairly thorough inspecting during 1918, we are unable to decide on account of the uncertainty of the thoroughness of previous inspection work, whether the insect is spreading rapidly, moderately or not at all. Personally, I am of the opinion that it spread during 1918 to a considerable extent.

Several state entomologists have made inquiry concerning what quarantine measures, if any, should be undertaken to prevent the introduction of the insect into their states. I think it would be dangerous to permit the shipment from the infested area of plants with soil around the roots. I understand that Dr. Headlee has in effect regulations to prevent the movement of such plants. There is danger also of the distribution of the beetles in green, sugar or field corn, since the beetles freely penetrate the tips of the ears of green corn to feed upon the milky kernels. The danger of the spread of the insect in this way seemed so important that a quarantine of green sweet corn was established by the Federal Horticultural Board, effective June 1, 1919, and adequate machinery will be provided for the inspection, certification and movement of this crop.

Several things interfered with the vigorous prosecution of the field work planned for 1918, as insufficient funds, difficulty in obtaining in time machinery and insecticides, and difficulty in obtaining labor. We hope to surmount all of these difficulties next year and feel that 1919 and 1920 will be our big years in the work, and which will prove conclusively what can be hoped for towards the eradication of the Japanese beetle.

The establishment in the United States of the oriental fruit moth has

awakened a good deal of interest among entomologists and fruit growers. It may be that possibilities for injury by this insect have been over-emphasized. There is, however, considerable reason for fearing that the insect may become a first-class pest of deciduous fruits. It belongs to the same genus with the codling-moth. There are developed in the latitude of Washington four or five broods of larvæ each year, and the behavior of the insect in orchards coming under the speaker's observation leaves no doubt as to the capabilities of the insect for harm. Notwithstanding all of these facts the oriental fruit moth may, of course, succumb to the action of native parasites, or for other reasons fail to develop into a serious pest, a result which is much to be hoped for.

Funds were available under the appropriation for stimulating agriculture to make a rather thorough survey of the United States to determine the distribution of the insect. There were employed at one time or another some fifteen or eighteen inspectors, and while it was possible to inspect only the more important fruit-growing regions, yet the scouting was so arranged that had the insect been generally scattered over the country, it would have certainly been detected. Inspections were made of the peach belt of the South and representative peach and apple orchards were inspected in the middle Atlantic States, the middle West, the Rocky Mountain States and the Pacific Coast. Briefly the insect was found to occur only in a strip of territory that may be said to border on each side of the railroads between Washington and New York. In the environs of Washington, we have a rather severe infestation extending a few miles south into Virginia and northwestward to about Leesburg, Va., where large commercial peach orchards are located. The insect is pretty well present over southern Maryland, extending northward through Frederick and Washington Counties, Md. There is an infestation at Lancaster, Pa., and it has been taken in the environs of Philadelphia. Northern New Jersey is more or less infested, and the insect is rather generally present on ornamental and other *Prunus spp.* on Manhattan and Long Islands. There is an infestation in southern Connecticut and extreme southern New York.

Considerable difference of opinion prevails among entomologists as to the practicability of quarantine measures in the restriction of spread of this species, and perhaps something should be said on this subject. It should be borne in mind that the oriental fruit moth infests fruit, especially peaches, apples, pears and quinces and also the tender tips of nursery stock and orchard trees, particularly the peach. We may fairly judge of the probable effectiveness of quarantine measures in preventing the spread of the oriental fruit moth in fruit by what we know of the value of such efforts in preventing the spread of the codling-moth. In the case of an insect infesting fruit any adequate inspec-

tion and certification as to freedom from the insect would be exceedingly difficult to arrange, and would require a large force of inspectors and funds to make the work reasonably efficient. Even under such a system it is practically certain that the pest would gradually be disseminated in spite of all efforts to the contrary. A more logical plan would appear to be to provide for the inspection of orchards and quarantine movement into non-infested areas of fruit from orchards found to be infested.

In the case of nursery stock, the danger of distribution in the speaker's judgment is slight. Of course it is possible that some of the larvæ might still be in the tips of the twigs when the trees are dug and shipped in early fall, but in the case of nursery stock handled in the usual way, larvæ in most cases would have deserted the twigs and sought suitable places for the construction of cocoons in which to hibernate. Probably only in rare instances would the cocoon be found along the trunk of the little nursery tree, but more likely on the ground under accumulated trash, etc. Any quarantine plan to be effective, therefore, should pay especial attention to restricting the movement of infested fruit, the quarantine on nursery stock being merely incidental. In view of the extreme difficulty, if not impossibility, of restricting the spread of this insect by quarantine measures, such quarantines are, in the speaker's opinion, of doubtful utility and should receive the careful attention of state entomologists before being put in effect. Surely coöperation among state officials should be had and a uniform policy adopted, if possible.

In states where peach growing is now a large and specialized industry, as in portions of the South, the Alleghany States, the Pacific Slope and elsewhere, the officials charged with the protection of these industries from introduced insect pests will no doubt give careful consideration as to what should be done under the circumstances, considering in this connection the extreme difficulty of putting in operation measures which would really prevent the movement of the pest in fruits.

It is pretty certain that the oriental fruit moth will not be very troublesome to apple growers, since the methods of control employed for the codling-moth should also secure the control of this insect. In the case of peaches, however, the situation is not so favorable, since owing to the habits of the pest, it will be very difficult to materially control it by sprays, judging from results of experimental work along this line thus far carried out.

Mr. J. G. Sanders: I would like to ask Professor Quaintance whether he thinks it possible or probable that European authorities may quarantine against American apples on account of this insect.

Mr. A. L. Quaintance: That is a question I cannot answer. I

think European authorities have very rarely quarantined against American fruits on the grounds of danger of introduction of injurious insects. It is true that the German Empire and one or two other goverments quarantined American apples on account of the San José scale. It is my understanding, however, that in the case of Germany this quarantine was not issued so much on account of the San José scale as to favor growers of apples in that country. Personally, I do not believe Europe will quarantine against the oriental fruit moth.

Mr. T. J. Headlee: We do not want any misconception concerning the measures that are taken to prevent the distribution of the Japanese beetle on nursery stock into other parts of the United States. From the time the existence of this insect was recognized no plants have been allowed to leave the infested sections of the nursery without having all the soil removed from the roots. In view of the fact that the plants are moved when the Japanese beetle is in the ground as a grub, such precautions would seem ample to prevent the distribution of the insect on nursery stock.

Mr. E. N. Cory: You don't attempt to control the action of the individual in taking plants out of the areas?

Mr. T. J. Headlee: In response to Mr. Cory's question, up to the past season we have made no attempt to prevent individuals from carrying in hand, bag or vehicle, individual plants such as rosebushes from premises within the infested area. During the past season a campaign of education was put on among the people living in the infested district for the purpose of obtaining their coöperation in the prevention of this sort of movement. During the coming year still greater and we hope more effective efforts will be taken along this line.

President E. D. Ball: The next paper is entitled "High Temperature Fumigation and Methods of Estimating Radiation Required," by W. H. Goodwin.

HIGH TEMPERATURE FUMIGATION AND METHODS OF ESTIMATING RADIATION REQUIRED

By W. H. Goodwin, *New Brunswick, N. J.*

(Withdrawn for publication elsewhere)

Vice-President W. C. O'Kane: The next paper on the program is "The Potato Leaf Hopper," by E. D. Ball.

THE POTATO LEAFHOPPER AND ITS RELATION TO THE HOPPERBURN

By E. D. Ball, *Ames, Iowa*

The leaves of the potatoes were badly burned during the season of 1918 all over the whole northern part of the United States, from Montana to New York, and New Jersey south to Kansas and Ohio. In different places it was called "blight, tipburn, or aphis work." The writer's attention was called to it on July 17. At this time the early potatoes in southern Wisconsin were largely dying or dead from the trouble. On examining the injured plants it was found that the leaves with only the margins burned invariably had nymphs or cast skins of the potato leafhopper (*Empoasca mali* LeB.) on the under sides. Upon investigation, it was found that even the leaves that had been burned entirely brown still had the cast skins of the leafhoppers in numbers, showing conclusively, that the insects had been present on them for some time. Egg scars were also found on all burned leaves at this time. Oftentimes it was possible to find a leaf with a single egg scar, the five cast skins of the different stages of the nymph and the freshly hatched leafhopper, showing that the whole life up to that date had been passed upon the single leaf. The uninjured leaves were also examined, but no egg scars, cast skins, or nymphs were found on them. The adults were just beginning to fly and occasionally a fresh adult, apparently a new arrival, would be found on an uninjured leaf.

Description of the Injury (Hopperburn)

The injury varies somewhat with different varieties and different conditions of temperature and moisture, but in general, the first sign is a triangular burned area at the top of the leaf, followed by progressive appearance of burned areas, more or less triangular, along the margin. These areas coalesce as the burning progresses, until the entire margin of the leaf is brown and more or less curled up. The burned margin increases in width, until only a narrow strip along the midrib remains. In the worst cases, this strip and the midrib burn, the leaf dies, and later the plant succumbs, standing burned and dry.

On examining carefully the burned leaves, egg scars will be found in the midribs and leaf stems, as shown in 2, 3, and 4 of figure 7. Often the burned triangle at the tip will be found to extend back nearly to a place where one or more egg scars have so distorted the midrib that it has collapsed beyond that point. The burned areas along the margin will often be found to extend in some distance on the lateral

veinlets and these veinlets will appear collapsed and brown, to a point where there appears to be a series of punctures probably made by the beaks of the nymphs.

The more rapid growing varieties of potatoes suffered less than those of slower growth, apparently due to the larger number of leaves produced. Each leafhopper appeared to be able to destroy a leaf. If there were only as many hoppers as leaves, the plant kept on growing; if on the other hand, there were two hoppers to a leaf, it died.

The Relation of Hopperburn to Tipburn

Tipburn has been used for years, to designate any burned condition of the leaves, for which no causal agent could be found, the most common explanation being that it resulted from too rapid transpiration due to abnormal conditions of temperature and moisture, although Dr. L. R. Jones, in first discussing it, suggested that insects might be a factor in its production. It seems probable that a considerable amount of the injury referred to as tipburn, in the past, has been due to the leafhopper. On the other hand, there are, no doubt, other causes of the burning of potato foliage and it will be one of the problems of the future to differentiate these factors.

At first it was thought that there was a great variation in susceptibility of different varieties, but further study appeared to show that the variation was due to the difference in time that the foliage appeared on the potatoes.

Potatoes that were up at the time that adult leafhoppers were flying in the spring, were injured in about the proportion of their foliage. Potatoes that came up later, even if in adjoining rows, were not injured at all until the adults of the new generation flew to them in July and August.

In every case the first injury appeared on the older leaves, below the top. This was due to the fact that between the time the eggs were laid and the young nymphs had hatched and had time to produce the injury, new leaves would have grown above the injured ones.

Cage Experiments

A cage was put over a medium-sized potato, early in August, and between 200 and 300 leafhoppers added. In three days all of the upper leaves of the plant were rolled up and burned brown and the growth of the plant stopped. Following this, two cages were placed over potato plants of equal size. Another plant of similar size was selected as a field check. These plants were scarcely two-thirds of the height of the cages and were considerably burned on the lower half when caged.

In one cage, between 200 and 300 leafhoppers swept from the field

were placed. The leafhoppers on the other plants were carefully removed before the cage was put on. The third plant remained under field conditions and during the next three weeks of hot, dry weather, the burning developed upon the upper part of the plant in considerable amounts, so that the whole field showed a brown cast, where before it had looked green.

At the end of three weeks the cages were removed and the three plants examined, after which their tops were cut off and photographed and then preserved.

The plant on which the hoppers were placed (Pl. 5, fig. 1) had evidently died within a short time, then the leafhoppers died and later, two green shoots came up from the stem near the base. These were green and not burned, while the former top was curled up brown and dead. The check plant had grown but little in height and the burning had progressed clear to the top (Pl. 5, fig. 2). The plant from which the leafhoppers had been removed, had grown rapidly and filled the top of the cage. The leaves were broad, smooth and bright green, with long, acute tips and without a trace of browning (Pl. 5, fig. 3).

Is the Hopperburn Specific?

The closely related leafhoppers working on rose, apple, grapes and woodbine, produce a whitened appearance on the upper side of the leaves, due to innumerable minute white spots that are apparently the result of feeding punctures. These feeding punctures are practically all made from the under side of the leaves, where the nymphs are found. In no case, however, is there any marginal burning of the leaves, or any browning, until the leaves are so badly injured that they are practically dead.

In the case of the potato leafhopper, the effect is quite different. The burning occurs while the other parts of the leaf are apparently uninjured and the margin of the burned area is always sharp and definite. This leafhopper attacks dahlias and produces the same marginal burning, as well as the same egg scars and distortion of the midribs and veinlets as on potatoes. It is also found attacking water sprouts and fast-growing tips of box elder trees and producing the same type of burning. Water sprouts and fast-growing shoots of nursery stock, and apples are also attacked, the leaves curled and the tips burned. The upper leaves on fast growing raspberry canes are similarly curled and burned.

All the evidence at hand indicates that the hopperburn is produced in every case by this one insect and by this one only. Whether or not it will prove to be a specific disease like the curly-leaf, transmitted by

the beet leafhopper, is yet to be worked out, but in any case, its relation to the potato leafhopper seems to be a specific one.

Life-History of the Leafhopper on Potatoes

The life-history of this species has been studied mainly in connection with its work as a nursery pest and reported under the name of the apple leafhopper.[1] Washburn, Webster and others have reported it as having from four to six generations per year. In practically all of this work the three species of leafhoppers commonly found on apples have apparently been confused.

Parrott was the first to clear this matter up and Lathrop,[2] working at Geneva, first differentiated the life-histories of the three species. He showed that the rose leafhopper (*Empoa rosæ*) wintered as an egg, mainly on roses, produced two generations, the second one on apples; that *Empoasca unicolor* Gill, the true apple leafhopper, spent its whole life on apples, wintering as an egg under the bark and producing a single generation a year; while *Empoasca mali* LeB., hereafter to be called the potato leafhopper, wintered as an adult and produced two broods during the season.

The writer's observations during 1918 indicated that two generations were produced on potatoes. The adults flying in the spring at the time the early potatoes come up, laid their eggs in the stems and midribs of the leaves (fig. 7, 2, 3, 4.) These hatched into nymphs (fig. 7, 1c) that fed on the under sides of the leaves, remaining on the single leaf, as shown by the successive cast skins, unless disturbed or, in case there were several on the leaf, until it died when they would migrate to another. During July and early August the first generation changed to adults and deposited eggs again or flew to the late potatoes to start the second generation there.

Proof That the Leafhopper Caused the Hopperburn

That the burned condition of the potato leaves observed in 1918 was due to the attack of the leafhopper seems to the writer to be well established by the following summary of proof:

First: Cage experiments showed that the leafhoppers could burn and roll the leaves in three days and that plants from which leafhoppers were all removed grew rapidly without sign of hopperburn.

Second: All burned leaves showed on their under surface, either the leafhoppers, their cast skins or egg scars; often all three, while green leaves showed no traces of these. Injury was proportional to the number of leafhoppers.

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[1] A more extended discussion together with a complete bibliography will be found in the "Second Biennial Report of the State Entomologist of Wisconsin, 1919."

[2] Journal of Economic Entomology, Vol. II, p. 144, February, 1918.

1. Top of potato plant from cage in which leafhoppers were placed; 2. Top of check plant from field; 3. Top of plant from which all hoppers were removed; 3. (Lower electro.) Potato leaf showing hopperburn and the cast skins of the leafhoppers producing it.

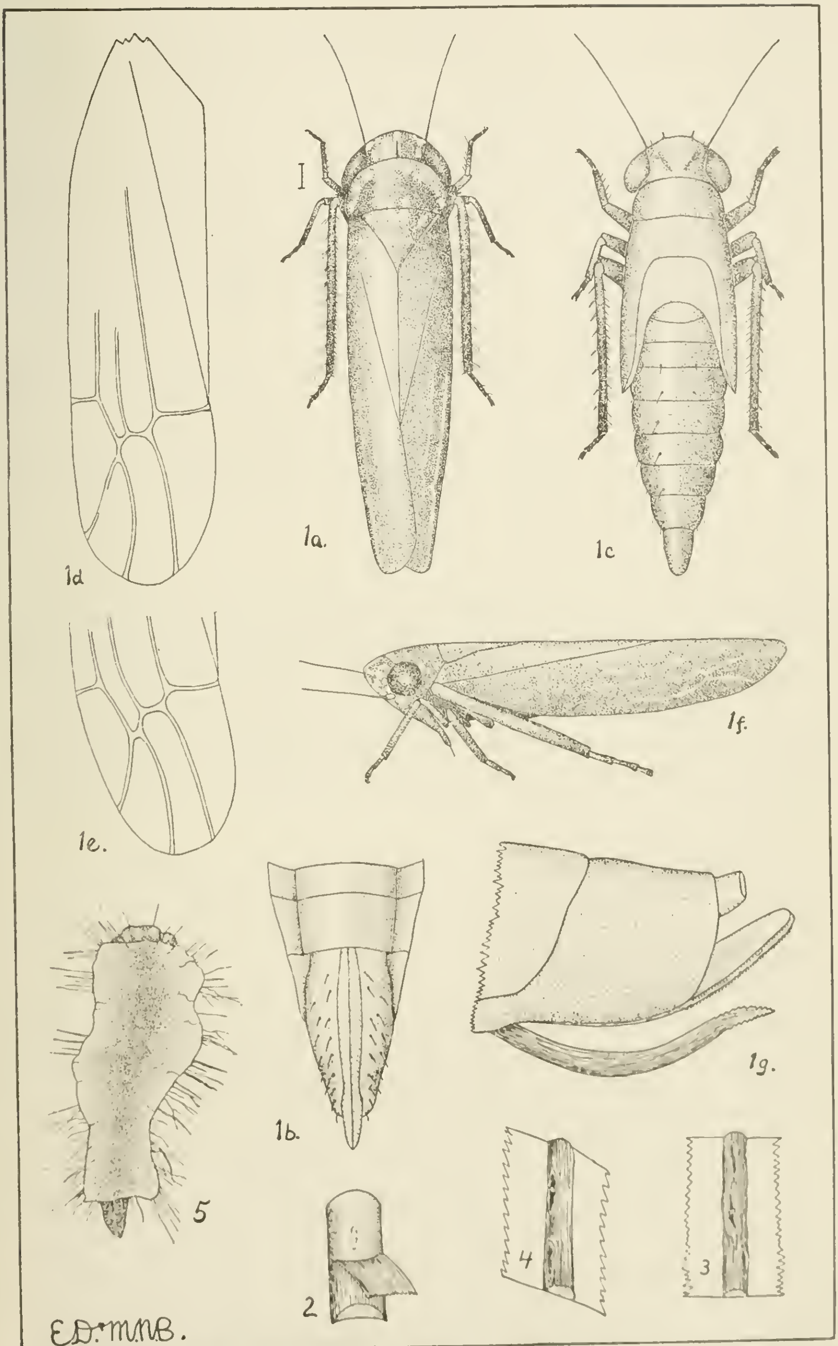


Fig. 7. The Potato Leafhopper; 1, *a* and *f*, the leafhopper; *c*, nymph; *d* and *e*, venation of elytron; *g*, "saw-like" ovipositor with which the eggs are thrust into the stems; 2, eggs in the stem; 3 and 4, egg scars in midrib; 5, nymph killed by fungus.

Third: Burning always appeared on the older leaves below the top of the growing plant, showing that time must elapse before its appearance (time for eggs to hatch).

Fourth: Burning on plants had no relation to position with reference to exposure, to sun or to soil.

Fifth: Burning in fields had no reference to soil condition, slope or exposure.

Sixth: Different varieties were affected according to the time they came up, or according to amount of foliage present when the leafhoppers were laying eggs.

Seventh: Epidemics of leafhoppers and hopperburn (called tipburn) have been observed at the same time, on a number of previous occasions.

Eighth: Other plants attacked by the potato leafhopper show the same distinct types of marginal burning: dahlia, box elder, apple and raspberry.

Control

Spraying with a rather strong kerosene emulsion or with Black Leaf 40, one pint to one hundred gallons of water, to which five pounds of soap have been added, was found effective in killing both nymphs and adults. The sprays must be applied from below, by means of a shepherd's crook made from $\frac{1}{2}$-inch gas pipe, or applied from above while the plants are drawn over by a suspended board. Two sprayings, a week or ten days apart, applied from opposite directions, were sufficient to control.

Vice-President W. C. O'Kane: Is there any discussion of this paper?

Mr. P. J. Parrott: Is this the same trouble that the plant pathologists call tipburn?

President E. D. Ball: I am with the plant pathologists in saying that there is no question but what some of the things they called tipburn in the past were not this, but a large part of it was this.

Mr. P. J. Parrott: *Mali* winters as an adult?

President E. D. Ball: Yes.

Mr. P. J. Parrott: What are its earlier food plants before it goes over to the potato?

President E. D. Ball: *Mali* goes over to a very large variety of plants.

Mr. E. P. Felt: Do I understand that this injury in the opinion of Dr. Ball is largely mechanical?

President E. D. Ball: I doubt it; I am inclined to believe that it is specifical, an infection or an injection.

Mr. McCampbell: When you advise the farmers to spray, how far apart would the sprays be?

President E. D. Ball: A week or ten days apart.

Mr. C. P. Gillette: Are the eggs laid wholly on the veins?

President E. D. Ball: On the midribs and the stalks of the leaves. As soon as they have destroyed the leaves they will feed on the stems and destroy them also. But they feed on the leaves apparently up to the time that the leaves die.

Mr. H. A. Gossard: We had in Ohio the maple injured similarly to tipburn and from the association of this species, we attributed it to that.

President E. D. Ball: This is the leafhopper that injures the growing shoots of nursery stock and young apple trees and burns them; it is the leafhopper that injures the growing tips of raspberry canes; it is not the leafhopper that injures the leaves of apple trees; it is almost never found on a slow-growing apple tree. On box-elder, it is only found on the water shoots or the fast-growing tips.

Mr. P. J. Parrott: In Geneva we have a great deal of trouble on the nursery maples.

Mr. J. T. Headlee: Can the speaker give us some idea of how much an infestation is necessary to bring about the results on potatoes that he describes?

President E. D. Ball: One leafhopper will destroy a leaf.

President E. D. Ball: The next paper on the program will be by Mr. O'Kane on "Limitations in Insect Suppression."

LIMITATIONS IN INSECT SUPPRESSION

By W. C. O'Kane

At the outset there should be some further definition of the subject of this paper. What I have in mind is a brief discussion of some of of the difficulties and problems that arise when the entomologist faces the task of organizing a campaign against a new and serious insect outbreak. Necessarily these difficulties and problems will vary widely with the insect, the part of the country invaded, the host plant and other factors, including the entomologist himself. Therefore that which follows can be only the view of one entomologist, based on an experience necessarily limited and on contact with only relatively few serious insects. That which constitutes a difficulty in New England may turn out differently elsewhere, with another type of citizen to deal with and with another man to do the dealing.

However, no matter where the work or who the worker, there is at

least one limitation that is certain to make itself felt at the beginning of the campaign. That factor is the lack of accurate scientific knowledge of the pest that is causing the outbreak: its life-history, the intricacies of its habits, its preferences as to food plants, and, in turn, the life-history and habits of its insect enemies.

Seldom, I think, shall we find available complete knowledge as to the majority of these vitally important points. If the pest has been introduced from another country we shall certainly have to work out a detailed study of it in this country, not only because recorded information about it in its native habitat will likely be scanty, but because its behavior and its reaction to natural enemies may be a new story here. Clearly, this knowledge must be had before a well-grounded campaign of control can be undertaken.

The agencies that may undertake such a study are available in various quarters,—in our state experiment stations, the state colleges, the state divisions of insect suppression, where such exist, and the Bureau of Entomology of the United States Department of Agriculture. Whatever of these agencies charge themselves with the study, there should be correlation between their work and the efforts of those who have the campaign of control laid on them. Men who are at work on the control side of the problem, if they are scientifically trained, will discover new details that need elucidation and will help to interpret scientific facts as they come to light. Men in investigational work, if in touch with those charged with control, will help preserve an atmosphere of inquiry. Certainly, each will do the better work under the influence of close relationship.

Control measures themselves may, of course, be vested in various individuals or institutions. The entire undertaking may be laid on the Federal Bureau of Entomology. It may devolve solely on the state official in whose jurisdiction the outbreak has begun. We have had examples of both plans.

If the insect is one of great importance, especially if it is an introduced pest that has gained a foothold in only a limited locality but promises to spread to many other states or throughout the country, then it would seem clear that the larger part of a campaign of control should be undertaken by the Federal Bureau of Entomology. A lesser part may be undertaken by such states as are at the moment concerned.

Two arguments may be offered against this theory. A state remote from the outbreak may urge that it should not be called on to help finance control of a pest that is two or three thousand miles away and may never reach its borders at all. It may argue further, that the area which has been so unfortunate as to acquire the pest is not entitled

to bequeath the penalty for that misfortune to other states, any more than it would assume the right to ask other states to help bear its burden of fire losses. As a matter of fact, however, in the case of any really threatening insect that has been introduced into the United States at some point and has actually become established, the pest is a matter of concern for other states, usually for all of them. It has made its start at one particular point, not through the carelessness of the state, as a rule, but by chance; and, in any event, the personal views of individuals as to responsibility will have no effect on the dispersion of the pest into new territory.

The state in which an outbreak has begun may fairly assume an obligation to assist in control measures. In the first place, it has the problem within its midst. The thing is there. It is doing damage. It is a fact on hand. Aside from this, the state may be of real assistance to the federal authorities. For example, a federal quarantine can concern itself only with shipments interstate. Movement of the pest or its host from the infested area to other areas not invaded and within the same state is not subject to control by the federal regulations. Such movement may be controlled by state authority.

It would seem, therefore, that a campaign for control of an insect outbreak may profitably be laid upon both the Federal Bureau and the states immediately concerned; and this applies as well to the necessary study of the insect and its enemies.

The nature of the outbreak itself will determine what degree of control may properly be undertaken. But that degree should be thoughtfully and carefully weighed early in the campaign. It is one thing to retard the spread of a new insect pest; it is another thing to control it; it is still a different thing to suppress it; and it is again otherwise to exterminate it. Very rarely, indeed, may we rightly set about our campaign with the promise of extermination, either implied to ourselves in the arrangement of our campaign, or expressed to the public in any announcements or, especially, in requests for funds. Once in a great while an outbreak arises where actual extermination or eradication is reasonably within hope. For example, I feel that we have such a situation at this moment in the European corn borer, although the possibility of actual extermination is problematical and will cease to be a possibility in another year or two. The work in progress against the gipsy moth is, to my mind, partly a matter of retarding spread, partly a campaign for control through the introduction of parasites, but only remotely a possibility of suppression and the latter only if it should happen that the introduced parasites prove extraordinarily efficient. It is not now a campaign of extermination, though once, years ago, it had that possibility in it.

It is not proper to speak of extermination or to hold it out as an inducement in asking for public funds, unless actual extermination is reasonably in sight. This may be a limitation, for the public likes to think of eradication rather than control, and quite likely will be quite unable to see why actual eradication is not entirely feasible. But if eradication or suppression is promised without sufficient foundation, a mistaken idea is built up which, eventually, will have to be corrected.

It is equally unfortunate to think of eradication in drawing up one's own plans if such an outcome is improbable. Those measures that would be justifiable if eradication is actually to be sought may become a sheer waste of money if a less degree of control is all that can possibly be expected. I must confess to a feeling that sometimes, as entomologists, we have entered on a campaign drawn up on the basis of eradication and involving heavy expenditures, whereas the best promise of ultimate solution lay in accepting the new pest as a permanent resident of our fauna, and determining that it should occupy as low a natural level as possible, in part through systematic introduction of its natural enemies. It must be acknowledged, of course, that it may be possible to get public money for suppression by mechanical means, where such funds would be more difficult or impossible if they are to be spent for travel abroad and for the study of the natural enemies of the pest. Sometime soon I hope that there may be arrangements concluded by which, as I think already proposed by Doctor Howard, we may enjoy the permanent services of experts, whose task it will be to study and to send to us the parasitic enemies of various serious pests that we already have or may acquire.

Granted, however, that direct means of suppression such as spraying, must be undertaken on a large scale, in the course of a campaign to control an insect outbreak, will it be desirable to get this work done by placing the burden of responsibility on the private property owner or should it be undertaken by men employed by the state or federal authorities?

If the insect is really a very serious one and if the aim of the campaign is to exterminate it or to stop spread, then I feel that dependence on the owner of private property will be wholly inadequate. There are various reasons for this. Eradication must be absolutely thorough. It does not mean to do a job that is 60 per cent complete or 80 per cent complete. It means to approach closely 100 per cent. Even suppression in the stricter sense means thorough work, properly performed at the proper time, and systematically carried through wherever the pest exists.

There are many private property owners who could do their share, having the money, the time and the intelligence. But even some of

these will fail because they will delegate the work to others who will prove incompetent or because they themselves will, on account of their multiplicity of interests, fail to move at the right time.

In contrast to these favored individuals there are many others, probably a majority, who lack the means, the time or the understanding to carry out real control measures. Their intentions may be excellent but their performance will not average high.

Against this idea it may be argued that statutes can provide for compulsory suppression, requiring a property owner to take certain measures, and can make a further provision that, if he fails, the work shall be done by a public official and the cost charged against the property as a part of his taxes. This will not necessarily succeed. No statute can make a man do thorough work if he is inclined to be careless. No law can teach every individual that adherence to some seemingly unimportant detail may be the key to success in control.

Furthermore, there is a definite limitation as to the amount of cost that the statutes may charge against a property. This is true whether the law requires the owner to do certain work or whether it provides that the work shall be done by a public official and the expense charged in the taxes. In either event it is necessary to limit the charge to some percentage of the assessed valuation of the property concerned. The maximum percentage that appears allowable is one half of 1 per cent. To assess that much means, usually, to increase ordinary taxes by 25 per cent. But one half of 1 per cent for a farm assessed at $5,000 is only $25, and the latter sum may be only a tenth of the actual cost of the work that should be done on the property in question.

If it be argued, in turn, that the state or federal government may properly assume the remainder, the reply is that the government had better assume the whole thing and do the job, thus placing it in the hands of trained men who have that one thing on their mind and whose duty it is to perform the task completely and at the proper time.

If, however, the campaign of suppression at hand is one of more liberal interpretation, in which the aim is to mitigate the damage done, to retard spread, to establish natural enemies, in other words, to accept the pest as a new member of the fauna, but to bring it to the lowest possible level of normal abundance, then there is good reason for asking the property owner to assume from the start an individual share in the burden of control. Indeed, to do anything else is to convey to the mind of the people an impression that the state or federal government is going to assume full responsibility for the pest in question and that the private property owner need not concern himself about it, either now or in the future.

To get the individual to conduct proper control measures means to

carry through a campaign of education and stimulation. In fact, in planning any comprehensive program of insect control there is reason for adopting a definite schedule of educating the people, in order that they may give to the problem intelligent and competent support, financial and otherwise.

At the best, the results of such a program of education will fall far short of the mark that one would like to set. When it would seem that certainly every citizen in the state must have come to understand the principal facts about a disastrous insect outbreak, the entomologist certainly will discover that six out of ten of those with whom he talks have practically no real conception of the problem and probably are sadly mixed in such information as they have absorbed.

It follows that every available means must be used if a considerable percentage of the public is to be reached and to be taught the essential facts that eventually the property owner must know. The newspapers will reach some, although their message will actually get into the minds of a much smaller number than one at first anticipates. Circulars and bulletins serve their purpose, but here, again, I doubt if more than one out of five mailed out is read or absorbed by the recipient. Posters can be made to help, provided they are very brief, so that their import can be seized at a glance. Any printed matter should invariably be simple, concise, void of technical terms and well illustrated. One page is better than two if one can possibly suffice. Two pages are better than four.

The spoken word will get a message home where no circular or bulletins can find entry. People will listen to that which you say though they may lay aside that which you have had printed for them. The best combination is the spoken word, reinforced by the printed circular distributed at the same time, and exemplified by the insect itself or its work actually exhibited.

At the best, there is apt to be difficulty enough in getting adequate funds for a real campaign of eradication or of strict suppression of a threatening insect. Certainly sufficient funds constitute an absolutely vital factor if the campaign is one of this nature. If it requires $100,000 to suppress a new insect at the beginning of its career, to spend half of that sum may be practically to throw the money away. The campaign must go the whole way. To stop short of the whole task is to build a bridge that lacks one or two spans. It may be an excellent structure to look at but it will be no good as a bridge.

And, finally, there is the limitation of human capabilities among those who are planning and directing the campaign. I believe that seldom, indeed, shall we find, in the same man, the qualities that will make him successful in conducting the scientific investigation of an

insect and will, at the same time, make him competent as the administrative head directing the staff who carry out the measures of suppression. On the other hand, as he is more typically an administrator, so his talent will less readily find expression in the details of investigation. There is need for specialists in both fields.

President E. D. Ball: The paper is now before us for discussion.

Mr. T. J. Headlee: We have heard a great deal during this meeting about the necessity of the business administrator in carrying out work for the suppression of injurious insects. While I agree heartily with the idea that a business-like administration of such a project is a necessity, I want to point out that a purely business administrator is just the man not to have in charge of such a project. He believes from his experience that the methods of procedure should be easily and definitely laid down and he will have no patience with the uncertainty which the nature of the problem creates in the mind of the entomologist. Pure business administrators for large projects of this kind, for directors of experiment stations and presidents of colleges are likely to prove a failure, because the very standardization which such a man will tend to introduce will destroy the initiative and render sterile the mind of the specialist without freest activity with which success cannot be had.

Mr. McCampbell: In the matter of educating the public, I wonder if you realize how far your appropriations would go if you spent them with some of the weekly and farm papers in the form of pure editorial matter. My observations in Monmouth County are that the farmers there read the two country papers religiously; they read everything, and if the experiment station in New Brunswick wishes to reach those farmers, let them get up a nice readable story which the farmers can understand, and bring it right home to them, you will reach every farmer in the country. A little bit of time spent with those editors will get you two to five times as much through the editorials. I think this would be a wonderful way to get this information to them, and I am sure it will do lots of good.

Mr. H. A. Gossard: I wish to call attention to the fact that if we are going to call upon the infested districts to bear the full burden of suppression, that certain parts of our country will be loaded with nearly all of that expense. The great ports of entry for insect pests are in the New England and Middle States, and nearly all of our serious pests have gained entrance into the country from these points. We cannot reasonably expect that these states will pay for everything or feel that it is their duty to suppress all pests that may have entered

the country through their ports of entry. If we are going to get adequate means, the whole country must get under the burden and help, otherwise these few states will get weary of the load and leave it to those states which are most interested, but which won't realize what they must do to stay the invasion, until it is too late.

Mr. C. P. Gillette: We speak quite often about insect extermination. I would like to have the members of this body give us a list of the insect pests we have exterminated in this country.

President E. D. Ball: We have exterminated the gipsy moth in half a dozen places; wherever they have tried, since they really took hold of it.

Mr. J. G. Sanders: The pink bollworm is well under way.

President E. D. Ball: The potato bug has been exterminated in some countries we know.

Mr. W. D. Pierce: The cattle tick has been exterminated in whole states.

President E. D. Ball: The scabies is practically eradicated from the western range.

The next paper is on "Control of the Chrysanthemum Gall Midge with Nicotine Sulphate—with Notes on Life-Cycle," by T. L. Guyton.

NICOTINE SULFATE SOLUTION AS A CONTROL FOR THE CHRYSANTHEMUM GALL MIDGE, DIARTHRONOMYIA HYPOGAEA H. LW.

By T. L. Guyton, *Harrisburg, Pa.*

A brief study of *Diarthronomyia hypogæa* was made at the Ohio Agricultural Experiment Station under the direction of Prof. H. A. Gossard. The writer is indebted to Professor Gossard and Mr. J. S. Houser for helpful suggestions in applying control measures.

Diarthronomyia hypogæa, a European pest for many years, was first recorded in this country in 1915 by Dr. E. P. Felt from specimens taken from greenhouses in Michigan. Professor Essig of California reported its presence in that state in 1915 and 1916. The first known outbreak in Ohio greenhouses was in February, 1918.

Life-History as Noted in Greenhouse

This study extended from the last of February to first of May, and one complete brood was observed. The length of the life-cycle is from forty to fifty days in a greenhouse where the temperature was about 70° F. The eggs are placed promiscuously about the young, growing part of the host plant, and the number deposited by each female is from 80 to 150.

Control Work

Nicotine sulphate solutions were used first of all with a hope of penetration sufficient to kill the larvæ within the galls. Upon examination a few hours after application a number of dead individuals were found at the point of emergence from the gall. Cages were at once prepared and tests made with the following results:

Table I. Results of Nicotine Sulphate Spray on Emerging Chrysanthemum Midge.

Spraying Done 2/23	"Pot 1" Sprayed with 1-500 Nicotine Sulphate and Soap		"Pot 2" No Treatment		"Pot 3" No Treatment		"Pot 4" Sprayed with 1-250 Nicotine Sulphate and Soap	
Date of Observation	Emergences		Emergences		Emergences		Emergences	
	Dead	Living	Dead	Living	Dead	Living	Dead	Living
2/25	0	0	0	2	0	2	3	1
2/26	0	0	0	0	0	3	1	0
2/27	0	0	0	0	0	0	2	0
2/28	2	0	0	9	0	7	6	0
3/1	4	0	0	15	0	0	2	0
3/2	3	0	0	20	0	4	5	1
3/4	0	0	0	38	4	6	1	1
3/5	0	0	0	0	0	0	0	0
3/6	3	0	0	10	0	9	0	2
3/7	3	0	0	5	0	3	0	1
3/8	0	0	0	1	0	1	0	0
3/9	0	0	0	2	0	0	0	0
3/11	0	0	0	0	0	0	0	0
3/12	0	0	0	1	0	0	0	0
3/13	0	0	0	0	0	0	0	0
3/14	0	0	0	3	0	0	0	0
3/15	0	0	0	2	0	0	0	0
Total	15	0	0	108	4	35	20	6

The cages were prepared by placing a heavily gall-infested plant in a five-inch flower pot, and covering the surface soil with about one-half inch of pure quartz sand. The plant was caged by placing a large lamp chimney over it. The top end of the lamp chimney was closed with one thickness of cheese cloth.

Greenhouse Tests of Nicotine Sulphate

A bench about twenty feet long and three feet wide, containing about 250 plants of a number of varieties of chrysanthemums, all infested with galls of the midge, was used as a trial. The plants on this bench were the only chrysanthemums in this particular room of the greenhouse, and they were cared for as in the usual practice of the caretakers. The plants were sprayed with a one to five hundred solution of nicotine sulphate and water, to which one ounce of caustic soda fish oil soap had been added to each gallon of solution. The spray was applied six times in all, with five-day intervals between each application. Observa-

tions made at the end of the treatment are: The plants were in a good growing condition, showing no ill effects from the spray application. No eggs or adult forms of the midge were to be found. Six plants had midge galls, the contents of which were blackened and soft as seen under a binocular microscope. Many emerged adults, galls and eggs of the midge were evident among check plants in another room of the greenhouse.

Examinations of the galls during the time of treatment showed that in many cases the larvæ and pupæ are not killed by the spray, but that the emerging adult is killed, probably by the moisture on its body coming in contact with the dry spray material on the outside of the gall. Thus to be effective in killing the midge, the spray mixture should be present throughout the period of emergence. Evidence was obtained which showed that at least a large per cent of the eggs are destroyed by this spray.

Conclusions

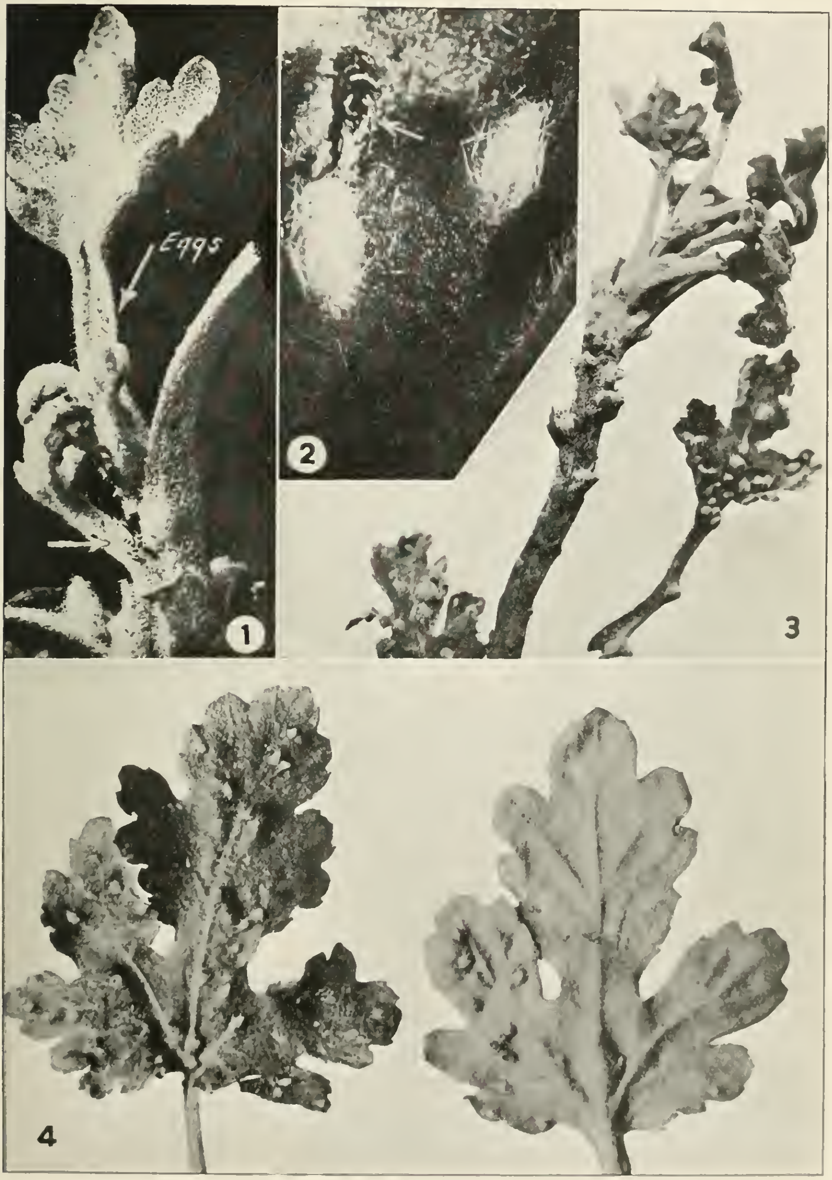
It is the belief of the writer that the chrysanthemum midge can be successfully controlled at the time of emergence of the adult by spraying with a solution made of one volume of nicotine sulphate containing 40 per cent nicotine to five hundred volumes of water, to which fish oil soap has been added at the rate of one ounce to each gallon of solution. Since all the adults do not emerge at the same time the treatment must be repeated every four or five days, as long as any living forms of the midge remain in the galls. The plants must be completely covered with the spray solution.

Mr. J. G. Sanders: This insect is comparatively new to greenhouse men, in fact it has occurred at widely separated points in the country. Those of you who have not seen its work will hardly appreciate the tremendous damage done to growing chrysanthemum plants due to the stunting of the buds.

Mr. E. R. Sasscer: For the past year or more we have been conducting life-history and remedial work in Washington with this insect. We found by using nicotine sulphate, and continuing to spray every second or third day for a period of about 35 to 40 days, the midge could be controlled. We have also tried burning nicotine papers, but have found that if you burn often enough to be effective against the midge, it will injure the plants. We have practically eliminated this insect in a commercial house by spraying with nicotine sulphate.

Mr. E. P. Felt: I would like to ask Mr. Sasscer if he has been able to try it against the box leaf midge.

Mr. E. R. Sasscer: No, I have not.



Diarthronomyia hypogaea: 1, Eggs on young portion of plant, enlarged; 2. Individual dead at point of emergence from the gall, enlarged; 3 and 4, Stems and leaves of host plant showing the galls, about natural size.

Mr. E. N. Cory: I might say that we worked on the box leaf midge some years ago, and in a small way. We were unable to get any results with nicotine sulphate.

Mr. E. P. Felt: Was the spraying at the time when you would catch the pupæ as they were pushing out of the galls? They have just about the same habit.

Mr. E. N. Cory: It was an attempt to get penetration and to kill the larvæ.

President E. D. Ball: We will call on Mr. Sasscer for a résumé of Mr. Woglum's paper on "Recent Developments in Fumigation with Liquid Hydrocyanic-acid."

Mr. E. R. Sasscer: I am very sorry that you have not time to hear this paper of Mr. Woglum, because it shows the latest developments of hydrocyanic-acid gas fumigation in California. You are all familiar with the old pot method where sodium cyanid is placed in the dilute sulphuric acid.

[See p. 117–123 of February issue for text of this paper. Ed.]

Mr. W. E. Britton: I would like to ask Mr. Sasscer if he has tried this out in greenhouse fumigation.

Mr. E. R. Sasscer: No, I have not tried it out. I hope to give it a test as soon as a suitable shipping container is found.

Mr. P. J. Parrott: What is the effect on the valves or the metal parts of your machine? We find that the valves give way after the third year of use.

Mr. E. R. Sasscer: I am unable to answer this question since all of this work has been under Mr. Woglum's supervision.

Mr. T. J. Headlee: I would like to ask the speaker if he has used the ordinary soda bottle, with the CO_2 gas?

Mr. E. R. Sasscer: It is understood that I have not used liquid hydrocyanic-acid and that all of the work referred to was done in California under Mr. Woglum's supervision. I am told that an apparatus working on practically the same principle as a soda bottle can be satisfactorily used.

Mr. W. H. Goodwin: Have they in any case used the oxygen or hydrogen steel drums?

Mr. E. R. Sasscer: I do not know. All of this work has been done in California.

Mr. W. H. Goodwin: I know that in our cyanide work where we use the liquid cyanide, all brass connections and valves will soon be

eaten away, and I know that the hydrocyanic liquid gas must have a much more serious effect than the cyanide.

Mr. E. R. Sasscer: Hydrocyanic acid is said not to injure cloth, and therefore tent burning is reduced to a minimum.

Adjournment.

[Papers read by title.]

THE WORK IN THE UNITED STATES AGAINST THE PINK BOLLWORM

By W. D. Hunter, *Bureau of Entomology and Federal Horticultural Board, U. S. Department of Agriculture*

Historical

The protection of the United States against the pink bollworm (*Pectinophora gossypiella* Saunders) was first seriously considered by the Department of Agriculture in April, 1913, when the writer brought to the attention of the Federal Horticultural Board the strong possibility that the pest might be introduced at any time in cotton seed from Egypt or other infested countries. Shortly thereafter a quarantine was promulgated to take effect on July 1, 1913. This quarantine prohibited the importation into the United States of cotton seed of all species and varieties and cotton seed hulls from any foreign locality, except the Imperial Valley in the State of Lower California in Mexico, where the cultivation of cotton is continuous with the growth of the crop in California. In August of the same year an amendment was issued which provided for the entry under regulations, for milling only, of cotton seed from certain additional northern states in Mexico.

It was soon found that the quarantine against cotton seed and hulls was not sufficient to protect this country for the reason that considerable quantities of seeds, in some cases as many as 600 per bale, were arriving in lint. Consequently means were taken to regulate the importation of lint and to require its fumigation in vacuum apparatus devised after a long series of experiments by Messrs. E. R. Sasscer and L. A. Hawkins. In the meantime the destruction of the seeds found in opening and cleaning foreign cotton was provided for in all mills utilizing such cotton, regardless of their location in the United States.

It was also necessary on account of the occurrence of the pink bollworm in Hawaii to place that territory on the same basis as foreign countries in regard to shipments of seed, hulls and lint.

During all this time, of course, it was not known that the pink bollworm existed in Mexico. Suddenly, however, on November 1, 1916, specimens of the insect were received through Mexico City from a

plantation in the Laguna district in the northern portion of the country. It developed that during 1916 about 400 carloads of Mexican seed had been shipped to Texas mills. Such shipments were unprecedented and due entirely to the disturbances in Mexico which had prevented the operations of the large mills in the Laguna, which normally crushed all of the seed produced there.

The Mexican seed shipped to Texas was received at eleven oil mills located in various parts of the state, some of them in actual contact with continuous cultures of cotton.

Control Measures in Texas

Immediately steps were taken to safeguard the Mexican seed in the Texas mills by early and special crushing and in other ways. The mill properties themselves were thoroughly cleaned under the supervision of the Federal Horticultural Board during the winter of 1916–17. This work was followed in 1917 by very thorough inspections by a number of agents of the cotton growers in the vicinities of the mills which had received the Mexican seed. The results of this work were all negative until September 10, 1917, when Inspector Ivan Schiller found a specimen of the pink bollworm in a field at Hearne adjoining a mill which had received 67 carloads of Laguna seed. On October 5 a single specimen was found near the oil mill at Beaumont, Texas, which received 114 carloads from Mexico, and on October 25 specimens were taken near Anahuac, in Chambers County.

The first two of these infestations, namely at Hearne and Beaumont, were very evidently due to the Mexican seed which had been received. The infestation at Anahuac, however, cannot be connected with the seed shipped from Mexico. All investigations which have been conducted point to the very strong probability, if not certainty, that the Anahuac infestation was due to the washing ashore and breaking of a number of bales of Mexican cotton which were carried inland by a storm which passed over Galveston in August, 1915.

Plan of Operations

In the three places where infestation was found the same general plan was followed by the board. The first step was to delimit the infestation, the second to destroy, as far as possible, any infestation existing in the fields, and the third to safeguard the cotton and cotton products originating in the infested territory.

The infestation at Hearne was found to be very limited. This was determined by inspections made by about fifty entomologists detailed from the Bureau of Entomology and by a number of regular employees of the board. Likewise the infestation at Beaumont was found to be

limited to the fields planted in seed from the mill. This seed was used for this purpose in violation of the agreement on the part of the mill that it should be crushed immediately.

The infestation at Anahuac was soon found to be very extensive. It extended 25 miles south of that place to Smiths Point, but this was not the end, since the work of the inspectors revealed the presence of the pest on the opposite side of the Bay in Galveston County. As this work was continued during the winter of 1917–18 specimens of the pest were found in 161 fields, extending from the Neches River practically to the Brazos River, a distance of 125 miles, and inland a distance of approximately 75 miles. The territory thus found to be infested covers 5,400 square miles, and includes all or portions of seven counties. It is considerably larger than the entire State of Connecticut and about three-fourths as large as the State of New Jersey.

While the work of delimiting the infestation in southeastern Texas was under way, the work of cleaning the fields was begun. The procedure followed was to cut down the cotton plants standing in the fields, place them in piles, then collecting by hand all of the bolls and particles of bolls on the ground, placing them on the piles of the stalks and burning the whole by the use of kerosene.

The country in southeastern Texas is sparsely settled, and the farms separated by great distances. The local labor available was entirely insufficient for cleaning the fields thoroughly and with dispatch. Consequently gangs of laborers were organized who were housed and provisioned and distributed by motor trucks at the expense of the department. At one time the department had over 1,000 laborers engaged in the work, as well as twenty motor vehicles. The cleaning of the fields cost the department $87,439.88 on 8,794 acres, an average of $9.94 per acre. The cost in some cases was as high as $30 per acre, where the fields were especially far removed from the camps, and where they were filled with stumps or grass, or otherwise difficult to clean properly.

The field work was greatly facilitated through the taking over of a number of trained men who were in the employ of the State of Texas and the Bureau of Plant Industry in the work of eradicating citrus canker.

The safeguarding of the cotton and the cotton products originating in the infested territory in 1917 (and in 1916, as that year's crop had to be considered nearly as dangerous as that of 1917) was accomplished by the exportation of the lint through the coöperation of the dealers and the crushing of the seed under special supervision in approved establishments in the City of Houston.

Quarantine and Non-Cotton Zones

In 1917 a special session of the Legislature of Texas, at the suggestion of the Department of Agriculture, had provided a pink bollworm act. This act became effective on December 28, 1917. During the period between the finding of infestation and the date the law went into effect, through the coöperation of the railroads and shippers and the vast majority of the farmers, practically effective voluntary quarantine measures were enforced. The special statute gave authority for the quarantining of districts found infested by the pink bollworm and for establishing non-cotton zones, if necessary. It was most fortunate for the cotton industry of the country that this statute had been provided.

The first steps taken under the law were to establish quarantine and non-cotton zones at Hearne and in southeastern Texas. In both cases a considerable area beyond the last points found infested was included as a safety belt. In southeastern Texas the width of this safety belt varied from 6 to 10 miles, depending on local conditions.

The difficulties in the way of establishing a non-cotton zone in southeastern Texas were considerable. The area included 38,000 acres of cotton in 1917. The territory had suffered several agricultural catastrophes, including the failure of the citrus industry. Although the region is normally too humid for cotton, there had been two dry years which had enabled the farmers to produce unusual crops, and this fact gave cotton in general estimation an importance which it cannot be said to deserve. With war prices for the staple, the general state of the public mind at the suggestion of a non-cotton zone can well be imagined.

Obstacles Encountered

Although realizing the difficulties very keenly, the Commissioner of Agriculture, Fred W. Davis, and the governor of the state took the very commendable stand that the case required the establishment of a non-cotton zone, and the steps necessary to that end under the law were taken.

As was expected, a few farmers, through lack of information and some for other reasons, planted cotton on their places. A test case of the law was soon provided. A planter in Liberty County had put in 125 acres of cotton. He was arrested under the provision of the law which prohibited the planting of cotton in non-cotton zones established by proclamation of the governor. It was found on the trial that the statute was defective in that, while prohibiting the planting of cotton under certain conditions, it did not specify a penalty. The penal code in Texas requires the indication of specific penalties in such

cases, and the state lost the case. The trial judge made it very clear in rendering his opinion that the general validity of the act had not been questioned. After the trial appeals were made by representatives of the board as well as by the state officials to farmers everywhere to comply with what was the clear intent of the law. These appeals were effective in many cases, but naturally a considerable acreage was planted on the supposition that the decision in the test case meant that the entire law was invalid. Altogether about 3,500 acres of cotton were planted in the non-cotton zone. Through direct appeals and appeals through bankers and merchants, much of this cotton was plowed out. In one considerable district every field planted was voluntarily destroyed. There remained, however, 1,741 acres which were cultivated and continued to grow.

The Law Found To Be Constitutional

The state and Federal governments coöperating undertook to establish in court that the growing of this cotton in violation of the governor's proclamation constituted the maintaining of a public menace. A test case was made against the president of an organization formed to fight the law, who had planted 30 acres of cotton. The trial lasted over two weeks. The judge went very thoroughly into all features of the law. The attack was on the score that the law was unreasonably drastic, that sufficient protection could be obtained by allowing the growing of cotton under regulations and the safeguarding of the products. However, the court decided that the law was reasonable and constitutional, and the defendant was ordered to destroy the crop forthwith. Upon his failure to do so in ten days, he was committed to jail. In a few days he was released on a writ of habeas corpus issued by a higher court, and a hearing was set for October 10.

An Agreement with Planters

During all of these legal complications, the cotton planted in violation of law continued to grow, and there was every prospect that it would be entirely harvested before the hearing on the habeas corpus case could be had. The agencies coöperating were therefore confronted with the facts that about 600 bales of cotton, of the value of approximately half a million dollars, had been produced; that if the state did not obtain custody of this crop, a considerable part would be smuggled out of the territory by means of the very numerous water courses in the region, and—anticipating a point which will be dealt with fully later—that no infestation by the pink bollworm had developed. It therefore became clearly advisable to make some provision which would give the state practical custody of the crop. After numerous plans were

considered, it was finally decided to make a compromise with the planters. This provided that the state would make no further prosecutions provided the planters would sign a formal agreement including the following points: (1) To turn over the seed and lint produced to the state, so that the former could be crushed under supervision and the latter exported; (2) to clean the fields thoroughly, depositing money at the rate of $20 per bale for each bale produced to guarantee that this work would be done properly; and (3) to agree not to plant cotton again during the term of any prohibition against it, and to submit voluntarily to an injunction from which there would be no appeal. After some little effort, all of the 134 persons who had planted cotton in violation of law signed the agreement, and the crop is now being disposed of under safeguards. It is considered that this plan is altogether the best one which could have been followed in view of the difficulties the state had encountered, and the actual fact that a large and valuable property had developed. The work of executing the agreement is being carried on by the state and Federal agencies coöperating, and has met with few important obstacles.

Volunteer Cotton in Non-Cotton Zone

During the season the Federal Horticultural Board has assumed a definite share of the work of maintaining a non-cotton zone in that it undertook to destroy all of the volunteer cotton growing therein. Such cotton appeared in considerable quantities in the majority of the fields throughout the non-cotton zone. The work of finding, collecting, inspecting and destroying this volunteer cotton was begun in June and continued for a period of six weeks. It was found, however, that some volunteer plants appeared during the summer, and it became necessary in September again to go over the entire territory. The district was divided into sections placed in charge of different men who employed local labor and collected the volunteer cotton plants. In all cases these plants were taken to central points where all of the fruit was given most careful examination by inspectors trained to find the pink bollworm or evidences of its work. In this way over 3,000,000 volunteer cotton plants and the fruit on them have been examined. In many cases these plants came from fields where infestation was determined to exist last year. The results up to the present time have been altogether negative. Not a trace of the insect has been detected.

In a single case a few plants were allowed to grow in a field which was infested in 1917. This was near Smiths Point in Chambers County, where much the heaviest infestation found in Texas had been located last year. It was easy to find bolls with ten or twelve larvæ within, and at least 75 per cent of the November bolls had more or less infesta-

tion. The field was planted to sweet potatoes in 1918. Fifty-one volunteer plants were allowed to grow and develop bolls. These bolls have been examined on five occasions very minutely by a group of the most competent inspectors available, but no infestation has been found.

General Scouting in 1918

An average of forty men were employed on the work of scouting during the season of 1918. This work included the general vicinities of the eleven mills which received Mexican seed in 1916, and a number of places to which hulls or other more or less dangerous material were shipped in 1916 prior to the time when the department took charge and safeguarded the products. In a few cases hulls which may have been infested were shipped to other states, such as Arkansas, Louisiana and Mississippi. At the places where these hulls were received, inspections have been made similar to those in Texas. Likewise thorough inspections have been made in some of the Eastern states which received Mexican cotton in 1915. In all cases the inspections have yielded absolutely negative results.

It seems almost inconceivable that the pink bollworm has been stamped out in the large territory which it was found to occupy in southeastern Texas, but the thorough inspections which have been made, including the examination of all the volunteer cotton plants, indicate that if it has not been exterminated, it has been reduced very close to the vanishing point.

The reasons for this apparent success, which it is hoped will be found real, are somewhat obscure. It is evident, however, that certain factors operated in a very important way towards the results which have been obtained. In the first place the work of cleaning the fields, that is, burning all portions of the cotton plants which might carry infestation, must have destroyed millions of the insects. That this was the case is evident from the fact that in many localities during the process of piling the plants, a person could remove bolls from the plants and in a few minutes find specimens of the pink bollworm. The winter which followed this work of cleaning the fields was unusually severe, bringing temperatures almost unprecedented in southeastern Texas. This condition must have caused the death of many of the larvæ which, hidden in bolls covered with earth in footprints and elsewhere, were missed by the laborers. At the same time it must not be assumed that the low temperatures were responsible for killing all of the insects which remained after the cleaning of the fields, since specimens in perfect condition were found on a number of occasions after the lowest temperatures had occurred. The last factor which

must have been influential in reducing the pest was the establishment of a non-cotton zone. It is true that there were 1,700 acres planted in this zone, but that was a small amount in comparison with 50,000 acres which would otherwise have been planted. Moreover it happened that practically all of the fields planted in cotton in violation of law were on land which was not in cotton during the preceding year, and there was no cotton whatever planted in the districts where the heaviest infestations were found. There the non-cotton zone was absolute. Some specimens which may have escaped both the cleaning of the fields and the vicissitudes of the winter may have appeared. If this was the case, the chances are that they were in the localities where there was no cotton, and their chances of propagating were eliminated or practically eliminated.

Observations made in India, Egypt and Brazil show that the pink bollworm, under certain conditions, may propagate in plants other than cotton. These include okra, Indian hemp, hollyhock and related plants. In so far as okra and hollyhock are concerned, these observations have been confirmed by investigations made recently in Mexico by Mr. August Busck and his associates. In Texas, in addition to okra which is very commonly grown, there are four species of Hibiscus even more closely related to cotton than okra, which might support the pink bollworm. These wild plants grow in large colonies, and are of very general occurrence. The inspections made during the season in the non-cotton zone have included the minute examination of many thousands of these plants. In cases all of the seed pods on large groups of these plants growing in the vicinity of pink bollworm infestations of the year before were examined with negative results.

The Outlook

Despite the encouraging outlook, it is not assumed that the pink bollworm has been eradicated in the United States. The situation is such, however, that it has been decided to allow the planting of cotton in the non-cotton zone in the southeastern part of the state during the coming season under regulations as to the seed planted, as to the handling of the crop, the cleaning of the fields and the destruction of growing crops found infested without compensation, as will enable the agencies coöperating to take early and radical steps, if necessary. The feasibility of safeguarding the cotton products produced in the territory has been proven by what was done with reference to the crop of 1917 and the outlaw crop of 1918. Certainly if the infestation has not been eliminated altogether it is much less than it was in previous years, and the risk, if there is any, to be carried in connection with the

planting of cotton in 1919 is much less than has been carried by the country for some time.

It is planned to maintain a large corps of inspectors to examine the cotton grown under supervision next season. These men will also inspect the fields growing in the vicinities of the mills which received the original Mexican seed. It is entirely probable that any situation which may arise next year can be handled speedily, and such steps can be much more satisfactorily taken than in the past on account of certain modifications of the pink bollworm law which will undoubtedly be provided by the next session of the Texas Legislature.

Protection Against Reinfestation from Mexico

As indicated earlier in this paper, since November 4, 1916, the importation of cotton, cotton seed and cotton seed hulls from Mexico has been prohibited. Later regulations have covered the entry from Mexico of cotton seed cake, meal and oil. The object of this last provision is to discourage the erection of oil mills along the Rio Grande, which would naturally cause the flow of large quantities of seed from the infested portions of Mexico to our border. It has already resulted in the dismantling and moving to the interior of a mill which was erected opposite Eagle Pass.

Since cotton seed may be carried accidentally in empty freight cars or attached to freight of many classes, regulations now in effect include the inspection and disinfection of baggage, the cleaning or disinfection of freight, express or other shipments except those which could not possibly carry infestation, restrictions on the entry of railroad cars, regulations for the transfer of freight, express and other shipments, certification of all cars or other carriers of merchandise as a condition of entry into the United States (excepting merchandise or other materials of strictly local origin), and the cleaning of domestic cars as a condition of receiving freight originating in Mexico for movement into the interior of the United States. The present regulations provide for the fumigation of the interior of cars with hydrocyanic gas and the spraying of the exteriors with kerosene emulsion. However, the department is now erecting houses into which cars will be run and fumigated. These houses will be located at all of the border ports, and will range in size from a capacity of one to fifteen cars, depending on the amount of the local international traffic. The houses themselves have been erected. It is believed that the machinery such as generators and fans will be installed within the next few weeks.

A Fresh Infestation

At about the time this was written, a new infestation by the pink bollworm was discovered in Texas. This is in the extreme western part of the state along the Rio Grande, where the insect has been found in widely scattered fields along a front of 150 miles. Everything indicates at this time that the infestation is due to the smuggling of seed across the river from Mexico. The region is isolated from any other territory in the United States in which cotton is planted by hundreds of miles of mountains and deserts. To control the situation there as it now appears is a matter of the utmost simplicity compared to the gratifying and possibly absolute control which has been obtained in other parts of the state. The finding of the new infestation at present, therefore, does not seem in the slightest degree to detract from the present generally hopeful outlook.

Investigations in Mexico

This paper would not be complete without at least a reference to the work of the Department of Agriculture in Mexico. This is conducted under the direction of Mr. August Busck. It includes studies of the bionomics of the species to serve as a basis for control measures which may be put into operation in case, by any chance, the pest ever becomes established in the United States. It also includes an effort towards the total elimination of the pink bollworm in Mexico. This project is by no means as visionary as might be supposed, and definite progress has already been made. This subject, however, must be dealt with more fully in a paper prepared by Mr. Busck, which in the nature of the case cannot be written until there has been time for further developments in Mexico.

PARASITE INTRODUCTION AS A MEANS OF SAVING SUGAR

By T. E. Holloway, *Entomological Assistant, Bureau of Entomology, Department of Agriculture*

This paper is a report of progress on work in parasite introduction, but it may also serve to point out the benefits which may come from the active interest of the agricultural public in any bit of scientific endeavor which appeals to it.

The control of the sugar cane moth borer, *Diatræa saccharalis*, has been a subject of investigation in Louisiana for many years. As time passed and experimental results accumulated, it became more and more apparent that only by the introduction of foreign parasites could

control be effected. In Cuba the moth borer was known to be much less injurious than in Louisiana, and in 1914 Mr. George N. Wolcott reported a tachinid parasitic on the larva. In 1915 the Bureau of Entomology arranged to investigate this parasite, with the intention of introducing it into Louisiana. Mr. U. C. Loftin was sent to Cuba, where he traveled about over the island, collecting parasites and sending them to the writer at New Orleans. Though they attacked the moth borer in Louisiana, they subsequently died out.

Experience has been gained, however, in methods both of collecting and breeding, and it was intended to continue the work the following year. But lack of funds and the department regulation prohibiting foreign travel during the war prevented parasite introduction during the next two years. The same conditions prevailed during 1918, but some of the sugar planters in Louisiana had become interested, and at the meeting of their association in New Orleans in June one member proposed that those so inclined subscribe one hundred dollars each to defray the expenses of the work. Thirteen planters immediately agreed to contribute this amount, and checks were received from some others after the meeting. Sufficient funds having been raised, a telegram signed by several prominent planters was sent to the Secretary of Agriculture, who approved the plans by telegraph the same day.

The writer proceeded to Cuba as soon as a passport was issued, and through the kindness of Mr. S. G. Chiquelin, superintendent of the sugar factory at Mercedes, Cuba, was able to make his headquarters at the private experiment station of the Cuba Cane Sugar Corporation. The director of the station, Sr. M. A. Centurion, received him cordially and gladly coöperated in every way possible. On July 12, the first sending of parasites was forwarded to Mr. E. R. Barber, of the Bureau of Entomology, and Mr. W. G. Taggart, assistant director of the Louisiana Sugar Experiment Station, who had agreed to receive the parasites at New Orleans. (Mr. U. C. Loftin, who had been in Cuba before, was no longer connected with the investigation.)

Four species of parasites were found, which had also been collected by Mr. Loftin. The egg parasite, *Trichogramma minutum* Riley, already occurs in Louisiana. Of the others, the most efficient is the tachinid, *Euzenilliopsis diatrææ* Townsend. The writer estimated that from 20 to 50 per cent of the moth borer larvæ were parasitized, though in one small field the percentage was much higher. The tachinid larvæ emerge usually from the larvæ of the moth borer, but occasionally from the pupæ. Soon after emerging they form puparia, which may be found in the tunnels of the host or nearby between the stalk and the leaf-sheaths of the plant.

As the attack of the moth borer results in the death of young cane

plants, the procedure was to walk through the fields until a dying plant was found, then dissect it carefully and examine it for either a borer or a parasite. The moth borer larvæ and pupæ were taken on the chance that parasites would emerge from a certain percentage of them. Parasite larvæ or puparia were very carefully collected and brought to the laboratory, where the puparia were placed in tin salve boxes with damp sphagnum moss and cotton. The salve boxes were in turn packed in pasteboard mailing cases and sent to New Orleans. At Mr. Barber's suggestion, holes were made in both the salve boxes and the tin bottoms of the mailing cases for ventilation, and it was found that fewer parasites died en route when shipped in this way. About 33 per cent arrived in New Orleans alive. All parasites were sent by ordinary mail, refrigeration not being used.

On reaching their destination, the puparia were placed on damp sand under glasses, and when the flies emerged they were transferred to cages containing growing cane infested with the moth borer. The most successful cage was a large one built over a corner of a sugar cane field. Ripe sweet fruits and honey-water were given the flies, such substances having been recommended by Mr. O. H. Swezey, of the Hawaiian Sugar Planters' Experiment Station, as being satisfactory for a tachinid of similar habits. The parasites passed through two and possibly three generations in New Orleans.

Of the other two parasites in Cuba, one is *Bassus stigmaterus* Cresson (*Microdus*) and the other *Apanteles* sp. They are comparatively rare, and it was thought best not to attempt to introduce them without further study. During the summer over 650 tachinid puparia, representing about 600 parasitized moth borers, were collected, while the moth borers attacked by the other two parasites amounted to not more than a half dozen by each one.

It was hoped by means of heated greenhouses to cause the tachinids to breed continuously through the winter, and two greenhouses containing growing cane were provided, but by December it became evident that the parasites were in a dormant state. On December 2 one puparium was found in a field cage, but the fly did not emerge and it seems that the insect is dead. It is believed that other parasites are present within the host larvæ and will emerge in the spring.

If the parasites become established in Louisiana and are as efficient there as they are in Cuba where they have to contend, by the way, with a secondary parasite, they will do much to control a pest which causes a serious loss annually. With a maximum infestation of the moth borer, it has been calculated both by entomologists and by sugar planters that the annual loss amounts to over 1,000 pounds of sugar per acre. Investigations to be published in Department Bulletin No.

746 show that the average infestation is about 50 per cent of the maximum, which roughly gives a loss of about 500 pounds of sugar per acre on the area infested, which amounts to some 300,000 acres in Louisiana alone. The total annual loss would thus be 150 million pounds, valued during pre-war times at about $7,000,000. This means that if the insect were controlled the Louisiana sugar planters would make approximately that much more sugar every year, or about one-fourth more than the average crop. There is also considerable damage to corn in Louisiana and to corn and sugar cane in Texas and Florida which has not been estimated.

A system of control by the native egg parasite, *Trichogramma minutum*, has already been found satisfactory to some extent. It has been the custom on the plantations to burn the leaves of the sugar cane plant which are left on the field after the stalks are cut and carried to the mill. This burning probably results in killing vast numbers of the egg parasite without a corresponding reduction in the numbers of the moth borer. To prevent it, the plowing under of the leaves has been tried for the past six years, a method of cultivation having been perfected in coöperation with the Louisiana Sugar Experiment Station, and it has been found that the infestation by the moth borer is never increased by this operation but may be considerably reduced, while the benefit to the soil is very marked. The cost of the additional labor required has been estimated by plantation managers to be less than one dollar per acre, and considering the fertilizing value of the leaves it really amounts to nothing at all.

By avoiding the destruction of beneficial insects and by adding one or more larval and pupal parasites to the very efficient egg parasite already present, it is believed possible ultimately to obtain a fair degree of control.

METHODS IN ENTOMOLOGICAL FIELD EXPERIMENTATION[1]

By W. P. Flint, C. F. Turner and J. J. Davis

The accuracy and value of results from field experiments, whether they be experiments in agronomy, in entomology or other agricultural subjects, depend largely, and in most cases wholly on the accuracy and reliability of the methods used in obtaining the data.

The past year the writers have been associated in the Hessian fly problem and have found it necessary to work out ways of obtaining data and to check and recheck the various methods to determine the most accurate and satisfactory from all standpoints. Although most

[1] Published by permission of the secretary of agriculture.

of these problems pertained to our work with the Hessian fly, they have a greater or less bearing on other entomological problems, especially entomological problems of the corn and grain fields, and the summarized results are here offered for the benefit of others working on similar problems; also with the hope that any inaccuracies in our work may be pointed out to us in order that a standard may be established which will enable one to more easily compare work done by investigators in different parts of the country.

Methods of Making Comparative Counts of Infestation

In the fall of 1917 several methods were tried[1] in an infested wheat field at Virden, Ill., to determine means of obtaining accurate records of infestation. Three systems were tried: the picking method, the linear yard method, and half square yard. The first mentioned consisted in stooping down and picking a plant at one side, one on the opposite side and one in front or behind, in all cases the plants being taken at random; this taking of three plants to be repeated after walking about ten steps. In picking it was necessary to take the plant from the side and not allow the hand to pass over the tops of the plants in selecting one, since the uninfested plants are usually higher and an inaccurate count will be obtained. Fifty plants were taken in this way. By the second method, five linear yards were selected by tossing a trowel five or ten yards ahead and examining all plants in the yard from the point of the trowel. The half square yard was similarly selected except that only two (= one square yard or five linear yards) were taken.

The results were as follows:

Table I—Results of Counts by Different Methods, 1917

Method	Total Distance of Wheat Row	Number Plants	Number Infested	Percentage of Infestation
Picking method		50	8	16
5 linear yards	15 feet	134	12	8.9+
2 half square yards	15 feet	183	15	8.2−

From a general survey the actual infestation was 12 to 15 per cent, and of the three methods used the picking method in this case gave the best results.

This fall (1918) more thorough counts were made[2] at Virden, Ill. In order to determine as nearly as possible the actual infestation of the plot, every other yard of two wheat rows, one on each side of the

[1] By Flint and Davis.

[2] By Flint, Turner and Davis.

small plot being used, were dug up and examined. A total of 71 yards or 1983 plants(average of 9.3+ plants to the foot or 694,468 to the acre, if rows are 7 inches apart) were actually dug up and examined. The accumulative percentages every five yards were as follows: 31+, 27+, 33−, 33+, 35+, 34+, 33−, 32+, 32−, 31+, 30+, 29+, 29+, 29−, 29−, the average for the total 1983 plants being 29− per cent, which we can consider as the average percentage of infestation of the plot.

The various methods were tried to determine the most satisfactory means of making counts and these included the picking method, one-third square yards, linear yards, and linear feet. The results are tabulated in Table II.

Table II—Results of Counts by Different Methods, 1918

Method Used	Taken by	Total Distance of Wheat Row	Number Plants Examined	Number Infested	Per Cent of Infestation	Average Per Cent of Infestation
3 linear yds.	Flint & Davis	9 ft.	76	19	25	25
2 third sq. yds.	Flint & Davis	10 "	98	26	25.5+	25.5+
10 linear feet	Flint & Davis	10 "	140	38	27.1+	28.9+
10 feet linear	Turner	10 "	119	37	31.0+	
Picking method	Flint		50	15	30	29
Picking method	Davis		50	14	28	
2 rows alternate yds.	Turner, Flint & Davis	213 "	1983	571	29.−	29.−

Although none of the methods used were far from correct, the linear foot and picking methods were most nearly accurate and from other tests, repeated at a number of our other sowing plots, they are more to be depended upon. This is as might be expected, since a larger number of small areas scattered over the field should give more nearly accurate results from the entire field than the same total area taken at fewer places in the field. Of the two most accurate methods just mentioned the picking method has been dismissed as the least satisfactory for experiment plots, first, because it requires some practice, second, because it is practically useless in the spring or even in the fall, if the wheat plants have tillered abundantly, and third, because it is desirable to use the same method in fall and spring. Since the linear foot method lacks the disadvantages just named, and is simple, requiring no previous practice, and is practically as accurate as any other means, we have concluded that it is the most correct and satisfactory.

On the other hand, the picking method is very useful for hastily determining fall infestations when making surveys over large areas and for this purpose can frequently be used to advantage.

In many cases it is possible to obtain relatively accurate data by examining plants from above and without digging them up to determine

percentage of infestation, but this method should not be used where accurate records are desired and especially in experiment plots where it is of much importance to determine the stages of the insect, severity of infestation, etc. Likewise this method cannot be used where the wheat has made a heavy growth, for frequently an infested plant will send up new shoots and it is often impossible to determine whether such tillers are individual plants or simply tillers of an infested plant, thus again showing a possible source of error if infestations are secured by simple examination of the plants as they appear above ground.

Summarizing we are led to conclude that the above-ground appearance of plants should be used only in generalizing the infestation, such as heavy, medium or light; that the picking method should be used only for fall scouting work when estimating Hessian fly infestations; and that for experimental plots where simplicity, accuracy and comparableness are essentials, the linear foot method should be followed and that at least ten linear feet be taken from each plot where counts are required.

Method of Taking Yields

While the problem dealing with the accuracy of obtaining yields from small plots is largely agronomic, it is as important for the entomologist as for the agronomist to be familiar with the most accurate and practicable means of obtaining these data.

Various methods have been practiced. Some agronomists insist that reliable records can be obtained only by harvesting the entire plots. Others believe equally reliable or even more accurate yields can be obtained by harvesting only small areas from each plot, usually about one-thousandth of an acre. In taking such small areas as one-thousandth of an acre, some prefer to take so many linear rods of individual wheat rows, while others take so many square yards.

Another year it is hoped that we may have the use of a portable threshing outfit in order to make a comparison of the different methods, but up to the present time we have not had this opportunity and wish simply to place on record the method which has been practiced in obtaining yields in our Hessian fly sowing experiments and to discuss its possible advantages and disadvantages.

Briefly, the method is to select five square yards from each plot, this to be bagged, shipped to a central point and there threshed, weighed and graded. Probably the most important point to be considered in securing yields from such small areas is the selection of the square yard. Observations indicate that selecting the areas by the hoop or other similar method which depends on chance is not accurate when as few as five square yards are to be taken. A fairer way is to

examine the plot and to select typical square yards, thus if one-fifth of the plot has a thin stand and the other four-fifths is heavy, we should select one square yard from the thin and four from the thicker area. One must, of course, be thoroughly unbiased in making his selections. Having selected an area, a yard stick is placed along one row. Having cut this row, the corresponding yard on the next row is cut and so on until five rows or approximately one square yard is taken. (Pl. 7, fig. 1.) Five such areas are cut from each plot, cured, placed in bags and shipped to a central point for threshing. The data taken includes not only weight of straw and grain, but also the grain is tested and its quality recorded, for we find the Hessian fly is responsible for damaging the quality as well as the yield of wheat.

As stated, we have no proof that one means of obtaining yields is better than another and indeed it appears that the practice just described does give us records above the actual yields, but we have every reason to believe, and much proof to show that the method we have used is comparable, which after all is the most important item.

Method of Estimating Injury

Estimates of injury by this or that insect are frequent in entomological literature, but seldom if ever have the methods used in estimating the injury been noted. No rules can be given to fit all cases. Certain methods which we have used are here offered, with the object of securing expressions of opinion and additional ideas from the members of this association.

Estimating the injury where acreages are killed outright is comparatively simple, but where injury is inconspicuous the difficulties are evident. In the former category we may include damage by white grubs, army worms, grasshoppers and chinch bugs when attacking corn, while in the latter group would be included injuries by scale insects, corn root aphis, Hessian fly, chinch bug in wheat, and joint worm.

In some cases where the insect damage is restricted to a definite area, it is possible to obtain an accurate estimate of injury by comparing yields of this area with a similar uninfested area in previous years as well as the year of injury, consideration being given to the climatic conditions in the two areas. Where the injury is widespread we know of no other method than comparing the yields during the season of insect injury with previous seasons yields, due weight being given insect injuries in previous years, and comparableness of climatic conditions and acreage. In estimating injuries where the damage is evident, the percentage of injury can be corroborated to a certain extent by a general survey and careful estimate of individual fields,

1. Method of cutting square yards of wheat to determine yields in sowing plots. Five such square yards are taken from each plot.

2. Hand flailing and fanning wheat, the method adopted in the absence of a more modern threshing outfit. The hand method is apparently accurate but very tedious.

but this is more difficult and less satisfactory with insect damage by such as the Hessian fly and joint worm. In the latter cases we can compare with previous years, but we have no basis to estimate accurately the injury in individual fields since there is no reliable comparison between infestation and injury. In the case of the fall injury by Hessian fly, the damage can be estimated only when the infestation is severe and the plants killed outright and in the case of spring injury by fly and by the wheat joint worm we do not know just how much or even the approximate damage by the insects. It is planned to get positive data on these facts another year for the joint worm and Hessian fly by enclosing large areas during the oviposition period of the fly and joint worm, two to be kept free from infestation and two to be infested by the introduction of joint worm adults and Hessian fly, respectively. It is to be hoped that others may be in a position to repeat these experiments and to make similar tests with other insects.

Continuity of Investigations

In order to secure reliable results it is important, and in the cases of such insects as the Hessian fly and corn root aphis, absolutely necessary, to continue the experiments over a period of years. This is well illustrated in the 1918 Hessian fly sowing experiments. Should we base our conclusions on this single season's results, our recommendation for fall sowing of wheat would be inaccurate since the fly-free date in 1918 was earlier than normal.

Continuity of observation is also very necessary in assisting the entomologist to predict the likelihood of an insect outbreak a following year and to determine the seriousness of such a possible outbreak. Thus a study of the likely hibernating quarters of the chinch bug in a certain section of the country extending over a comparatively large area and for several consecutive years is necessary to enable the entomologist by surveys from fall to fall, to determine with reasonable accuracy, the probabilities of a chinch bug outbreak and the extent and degree of the likely infestation the following season.

ELEODES OPACA SAY, AN IMPORTANT ENEMY OF WHEAT IN THE GREAT PLAINS AREA[1]

By James W. McColloch, *Associate Entomologist, Kansas State Agricultural Experiment Station*

Although the false wireworm, *Eleodes opaca* Say, was described in 1823 (Say, 1823, p. 263) it was not recognized as an insect of economic

[1] Contribution from the Entomological Laboratory, Kansas State Agricultural College, No. 38. This paper embodies some of the results obtained in the prosecution of project No. 100 of the Kansas Experiment Station.

importance until 1908. In the fall of that year several instances of injury were noted in western Kansas and considerable injury occurred in southwestern Nebraska (Swenk, 1909). Since the first recognized outbreak in 1908 there have been three well-marked outbreaks and reports of minor injury have been received every year. With the increasing importance of this insect it was deemed advisable to undertake a study of its life economy and accordingly in 1915 it was incorporated in one of the experiment station projects. The life-history has been thoroughly worked out, and insofar as time would permit, field studies have been made.

Distribution

Eleodes opaca has a wide distribution throughout the Great Plains area. Blaisdell (1909, pp. 177–178) records it from Texas, Oklahoma, Kansas, Nebraska, Colorado, and South Dakota. Wickham (1899, p. 60) reports it from Lyon County, Iowa. Fall and Cockerell (1907, p. 204) list it from Coolidge, New Mexico, and Evans (1903, p. 318) says it was taken in the Northwest Territories in 1879–80. Prof. R. A. Cooley recently furnished the writer with a single female taken at Culbertson, Montana.

In Kansas, this species is generally distributed over the western two-thirds of the state. Popenoe (1877, p. 36) says it occurs from Louisville westward. In the vicinity of Manhattan it is found in rather limited numbers and increases in numbers as one progresses westward across the state.

History and Importance

Previous to 1908, *Eleodes opaca* was not recognized as an insect of economic importance. It was known to occur in large numbers in the native grass lands throughout the Great Plains area but had never been mentioned as injurious. In the fall of 1908, a large number of worms, reported to be seriously injuring germinating wheat in western Kansas, were received by the Department of Entomology and determined as tenebrionid larvæ. According to Swenk (1909) severe damage also occurred in several Nebraska counties. He determined the larvæ as *Eleodes opaca*.

During 1909 and 1910 a few specimens of false wireworms were received with the information that they were doing a slight amount of damage to fall sown wheat. In the fall of 1911 a well-marked outbreak of this insect occurred in western Kansas, resulting in the destruction of several thousands of acres of wheat.

Again in the fall of 1914 and the spring of 1915, considerable injury was reported in several localities. The last and most severe outbreak

began in the fall of 1917, and is still in progress. In Kansas, west of the 98th meridan, the infestation has been general and entire fields have been destroyed. Reports of serious injury have also been received from Oklahoma and northwestern Texas. During the present outbreak the injury has not been confined to wheat, but has included oats and barley and occasionally corn and sorghums.

In all probability this insect has been responsible for much injury to wheat previous to 1908, but has been confused with the true wireworms and other insects. Many of the letters in the files of the Department of Entomology prior to this time refer to wireworms damaging fall sown wheat. From the text of these letters it would seem now that the insect in question was *Eleodes opaca*. In the field investigations the writer has often found the farmers confusing false wireworm injury with that caused by true wireworms, white grubs, fall army worms, Hessian fly, and winter killing.

Nature of Injury and Food

The principal injury by *Eleodes opaca* is done by the larvæ during the fall. At this time they attack the wheat seed immediately after planting and destroy it before germination. During dry years when the grain may lie in the ground several weeks before sprouting, the injury becomes most severe. After the seed germinates the injury becomes less noticeable and often ceases altogether. In some cases, however, considerable damage may occur after the wheat is several inches high. This was especially true in 1911 when the larvæ destroyed many fields by cutting the plants off just above the seed. Occasionally some damage occurs in the spring, due to the larvæ burrowing through the stalks or even cutting them off. The original food of the larvæ was apparently the roots and seeds of native grasses and weeds, but within recent years, due to the breaking out of the native sod, wheat has apparently supplemented this food. In the rearing work the best results have been had by feeding the larvæ wheat seed and bran. Other foods have been used, but in all cases the larvæ either died or made a very slow growth. Aside from wheat it has been possible to rear the worms on sprouting corn, foxtail seeds, and crab grass roots. In one instance larvæ were found feeding on the roots of bindweed in the field. During the present outbreak, serious damage has occurred in the spring to oats, barley, sorghums, and corn. In every case these crops were planted early on land where the worms had destroyed the wheat the previous fall. Wheat is subject to the greatest injury because it is planted at the time when the larvæ are reaching maturity and are voracious in their feeding. Swenk (1909, p. 334) reports larvæ found in ears of corn that had probably fallen on the ground.

Little is known concerning the amount of injury done by the adults. Swenk (1909, p. 336) states that the beetles fed voraciously on corn leaves in the breeding cages. When the experimental work was started, the adults were supplied with various weeds found in the wheat field, but in no case did they feed to any extent and the mortality was high. A few of the beetles fed sparingly on smart weed, dried wheat leaves, and fresh wheat leaves. Wheat heads that were not yet mature were then introduced into the cages and the beetles began to feed on them at once. Later soaked wheat kernels and bran were supplied and they fed on these readily. Mating and oviposition began soon after the change to this food. The fact that the beetles fed on the wheat heads and grain suggests the possibility that they may feed on them in the field, and in fact, recent investigations bear this out since typical injury has been found on wheat in the shock. It is not unusual to find large numbers of beetles about the shocks and stacks of wheat, and in many cases the fall infestation has radiated from such places.

Description and Life Economy

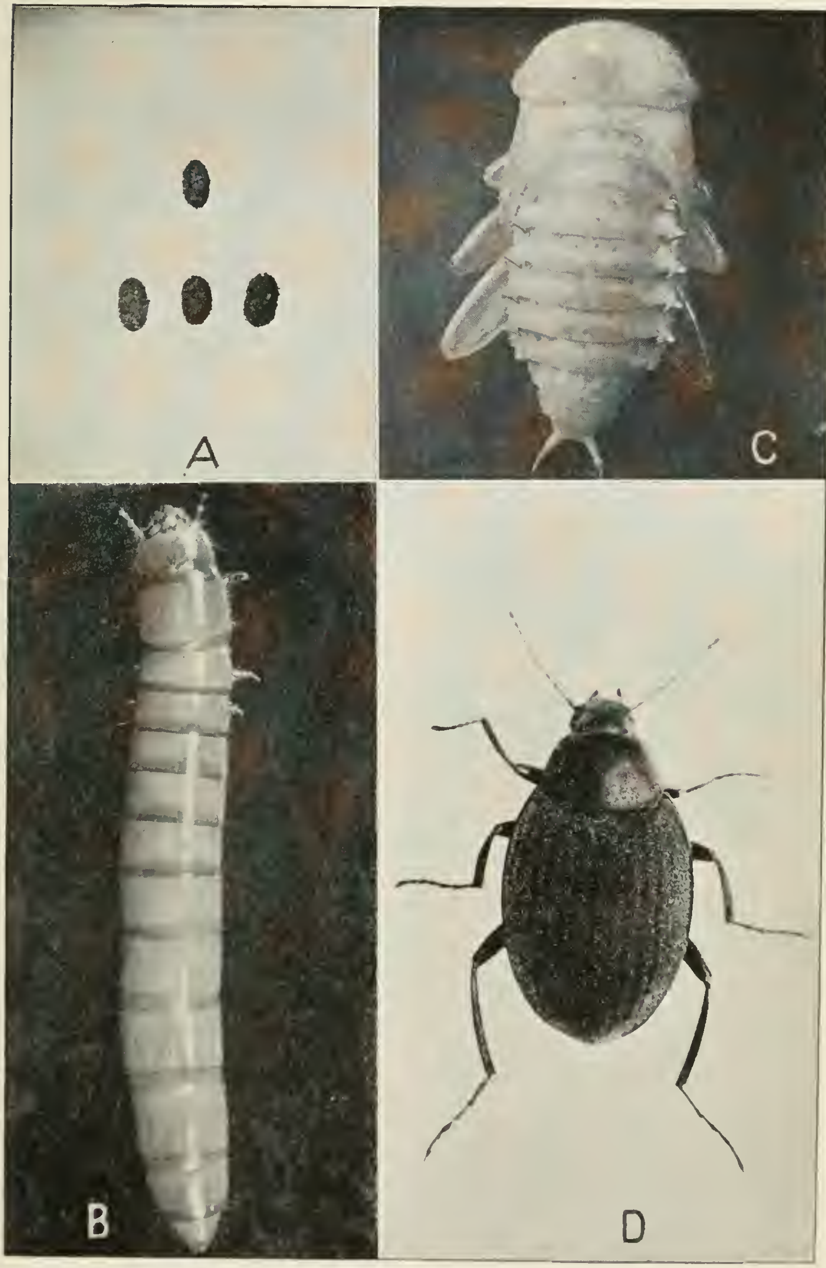
Method of Rearing.—The same methods were followed in the rearing of *Eleodes opaca* as were described by the writer (1918, pp. 214–215) for the life-history work with *E. tricostata*. The eggs were kept in the field insectary while the other stages were kept in a cement cave.

Egg.—The eggs of *Eleodes opaca* (Plate 8, A) closely resemble those described for other members of the genus, being oval in shape longitudinally, and circular in diameter. They show some variation in size, being from 1.1 to 1.4 mm. in length and from 0.50 to 0.65 mm. in width. They are white in color when deposited and change to a creamy yellow before hatching. A sticky secretion covers the egg, causing particles of soil to adhere to it. In the breeding cages the eggs were deposited in cavities in the soil ranging from one inch to five inches in depth.

The length of the egg stage varies with the temperature, and the season of the year. Eggs deposited during midsummer hatched in from 6 to 10 days, while later in the fall the stage was prolonged to 19 days. The first oviposition recorded occurred on July 5, and the last on October 4. The exact length of the egg stage was determined for 993 eggs, as shown in the following table:

Length of Egg Stage

Year	No. of Eggs	Min. Days	Max. Days	Average Days
1915	685	7	15	10.0
1916	144	6	19	11.3
1918	164	6	15	7.2
Average				9.7



Eleodes opaca Say: A, Eggs showing soil particles adhering; B, Larva; C, Pupa; D, Adult, female.

Larva.—As pointed out by Swenk (1909, p. 335) the larva of *Eleodes opaca* (Plate 8, B) closely agrees with the description of *E. dentipes* as given by Blaisdell (1909, pp. 497–499). The minor differences have already been discussed by Swenk, and need no further treatment. On hatching, the larvæ are about 2.8 mm. in length. Growth is comparatively rapid and by fall the worms are about full grown, being from 21 to 23 mm. in length.

The larvæ moult eleven times, including the moult when pupating, between hatching and pupation, the time between moults varying to some extent. An average of the length of each stadium, as determined for six larvæ, is as follows: first stadium, 4 days; second stadium, 3 days; third stadium, 4 days; fourth stadium, 6 days; fifth stadium, 8 days; sixth stadium, 13 days; seventh stadium, 15 days; eighth stadium, 12 days; ninth stadium, 18 days; tenth stadium, 199 days; eleventh stadium, 20 days. In moulting the skin is split on the dorsal side from the vertex back to the first or second abdominal segment, and the old skin is shed by the larva arching the back and drawing the body out, the posterior end emerging last.

The larvæ are subterranean in their habits, and thus far the writer has never observed them on the surface of the ground. Swenk (1909, p. 333), however, cites a case where they were found in large numbers on the surface following a heavy rain. They show a preference for rather dry soil, and usually the majority of the worms are found at the junction of the loose drier soil with the compact moist soil. In the fall they are found at the bottom of the drill rows where they are feeding on the seed wheat. In the spring they are more often located just beneath the surface of the ground, under clods and wind-blown soil. The principal food of the larvæ appears to be wheat kernels, but they also feed on the roots and seeds of native grasses and weeds, and on decaying matter. In the rearing work, the worms thrived best on soaked wheat and bran. During the spring of 1918, considerable injury was also done to germinating oats, barley, corn, and sorghums, where these crops had been planted on infested wheat land. The larvæ also feed on their cast-off skins and on larvæ that are dead or in a weakened condition.

Most of the larvæ become practically full grown by October, and thus pass the winter. Early in the spring they become active, and usually moult once during April. Pupation occurs during the last of April and throughout the month of May. The transformation to the pupal stage is preceded by a semipupal or quiescent state lasting about a week. The length of the larval stage as determined for the several years that the work has been in progress is shown in the following table:

Length of the Larval Stage

Years	No. Larvæ	Min. Days	Max. Days	Average Days
1915–16	3	329	355	338.3
1916–17	25	292	329	305.2
1917–18	22	311	346	329.1
Average				317.7

Pupa.—The pupæ of *Eleodes opaca* (Plate 8, C) vary from 13 to 15.5 mm. in length, and from 3.5 to 5.5 mm. in width. They are white in color with semitranslucent appendages. This color changes as development takes place, the body becoming creamy yellow and the appendages reddish brown. In general, the pupæ resemble those of *E. clavicornis* described by Blaisdell (1909, pp. 500–501), with certain modifications noted by Swenk (1909, p. 335).

Pupation occurs in the field during April, May, and June. In 1915, pupation began about April 20, reached its maximum May 4, and was practically over by June 1. The spring of 1918 was cold, and pupation did not begin until May 7. The maximum was reached about May 20, and pupæ were to be found until the last of June. Before pupating, the larva constructs a spherical cell from one-half to two inches below the surface of the ground. Here it remains in a quiescent state for about a week before transforming to the pupa. The length of the pupal stage has been determined for 149 pupæ, the pertinent data being shown in the following table:

Length of the Pupal Stage

Year	No. Pupæ	Min. Days	Max. Days	Average Days
1915	50	13	25	20.6
1916	4	9	13	11.5
1917	19	8	11	9.6
1918	76	8	23	11.1
Average				14.1

Adult.—The adult beetles (Plate 8, D) are fusiform oval in shape, black in color, and sparsely covered with whitish hair. The dorsum of the elytra is quite flat. The female is more or less broadly oval in shape and the abdomen is rather strongly convex. The anterior tarsi are unmodified. The male differs from the female in that the body is narrow and the abdomen is but slightly convex. The first two segments of the anterior tarsi are slightly widened and clothed with two dense pads of spongy pubescence. The males are 10 to 12 mm. in length, and about 5 mm. in width. The females are somewhat larger in size, being 11 to 14 mm. in length, and 5 to 7 mm. in width.

Emergence begins about the middle of May, and continues through

June. From this time on until the middle of October the adults are to be found in the field, the greatest number being present during July and early August. The normal length of life for the adult is from two to four months. Most of the beetles under observation lived from 60 to 90 days, while one male lived 130 days. Unlike *Eleodes tricostata* none of the beetles of this species hibernate over winter, and thus far the writer has never found adults later than October 18. While most of the adults emerged during June in the life-history studies, no mating was observed previous to July 3. During the four years that these studies have been under way, copulation has occurred the first week in July, and oviposition usually follows in two or three days. The first oviposition was noted July 5, and the last on October 4. The period of oviposition, together with the number of eggs per female was determined for seven mated females in 1915, this data being summarized in the accompanying table. Similar studies made the following years gave essentially the same results.

Oviposition Record for Seven Females, 1915

Female No.	Period Oviposition, Days	No. Days on Which Eggs Were Laid	Total No. of Eggs	Ave. No. Eggs Per Day for Period of Egg-Laying	Ave. Per Day for Days on Which Eggs Were Laid	Max. No. of Eggs Laid in 24 Hours
1	59	48	373	6.3	7.7	31
2	46	39	389	8.4	10.0	34
3	11	3	23	2.0	7.6	6
4	27	17	93	3.4	5.4	9
5	18	12	44	2.4	3.6	11
6	35	32	241	7.0	7.5	25
7	14	12	105	7.5	8.8	23
Average	30	23.3	181.1	5.3	7.2	19.8

While matings were observed frequently in all cages, the presence of the male was not necessary after fertilization once took place. In the case of female No. 1, the male died July 18, but she continued to deposit fertile eggs until September 6. The proportion of sexes as determined from reared and collected adults indicate that the females are slightly in excess of the males. Fifty-six per cent of the beetles taken in the field have been females, while 54 per cent of the reared beetles were females.

The adults of *Eleodes opaca*, like many of the other members of the genus *Eleodes*, are more or less nocturnal or crepuscular in their habits. In the field they are generally most active early in the morning, and about dusk in the evening, while during the hotter parts of the day they are to be found hiding under any suitable covering. In the prairie lands, rocks, manure, piles of weeds, and clumps of grass offer ideal hiding places, while in the wheat fields they are to be found under shocks and around stacks of wheat, under Russian thistles, in clumps of volunteer

wheat, and, in fact, any place where there is protection. It is not unusual to find them in large number under piles of Russian thistle that have collected along a fence. They also probably make use of the burrows of the various insects, and animals common to their locality. Snow (1877, p. 19) found twenty adults under bones near Colorado Springs, Colorado.

The adults apparently have a wide range of food habits. In the field they have been found feeding on evening primrose, Russian thistle, and alfalfa. In the rearing cages they fed sparingly on smart weed and on wheat leaves, while they showed a great preference for heads of wheat, soaked wheat and bran. Examinations made in the field indicate that they may feed on the wheat in the stack and shock, especially if it becomes damp. When confined on a small plot of young wheat they destroyed it in a few days. In one case a beetle was found feeding on a nymph of *Melanoplus differentialis*, but it was impossible to determine whether it had killed the grasshopper or not. It is not unusual for them to feed on the dead or weakened members of their own kind.

Length of Life-Cycle

Three generations of this insect have now been reared from adults collected in the field in 1915. Each generation has occupied about one year and the data secured in this study coincides very closely with the field observations. Taking the average length of the various stages, each brood required 341 days from the time the eggs were laid until the adults emerged. The essential data showing the length of the life-cycle are summarized in the following table:

Summary of the Length of the Life-Cycle

Stage	Minimum Days	Maximum Days	Average Days
Egg	6	19	9.7
Larva	292	355	317.7
Pupa	8	25	14.1
Life-cycle	306	399	341.5

Enemies and Parasites

Very few natural enemies are known to attack *Eleodes opaca*. Bruner (1892, p. 12) records finding the eggs of a tachinid on the elytra. Each year that these studies have been carried on a few beetles have been collected in the field from which have been reared specimens of the hymenopterous parasite, *Perilitus eleodis* Viereck. In no case has the percentage of parasitism been high, and the relation of this parasite to *opaca* has been given but little attention. From the notes at hand, the behavior appears to be the same as in the case of *Eleodes*

tricostata (McColloch, 1918, pp. 221–222). A gregarine (*Stylocephalus giganteus* Ellis) has frequently been found in the alimentary tract of the adults.

Swenk (1909, pp. 335–336) encountered considerable difficulty in his rearing work, due to the presence of what was apparently a bacterial disease. This disease usually began as a small dark red spot on the thoracic segments, or on the terminal abdominal segments, and spread rapidly, soon encircling the body, resulting in the death of the larva. Where several larvæ were confined in the same cage, the disease often spread to the others. The writer has often encountered this same disease, but since the larvæ were reared in separate boxes, it never spread to any extent. Two species of fungi have been found attacking the larvæ, namely, *Sporotrichum globuliferum* and *Metarrhizium* sp.

Physiological Relations

Eleodes opaca is a typical species of the Great Plains, an area of low rainfall and rather high temperatures. While it has been recorded as far east as Iowa, it does not occur in large numbers east of the 98th meridian. It is not common to the vicinity of Manhattan, being found only on the high, grassy uplands. The years of greatest injury in western Kansas have been characterized by excessive temperatures and low rainfall. In the life-history studies, eggs, kept in cages where the maximum temperature during the day was 112°, and the relative humidity 25 per cent, hatched in six days. The adults were not affected by a daily temperature of from 105° to 112° when the humidity was low. In ovipositing, the adults showed a preference for dry soil, and the rate of egg-laying decreased when the beetles were placed in cages containing moist dirt. Some moisture, however, is required by the adults, and this was supplied by feeding wet bran once a week. The larvæ thrived best in a slightly moist soil. When the soil was too wet to crumble nicely, the mortality increased rapidly. High temperatures, such as experienced by the eggs and adults, were fatal to the larvæ and the best results were had by keeping them in a cave where the temperature remained constant at about 80° during the summer, falling slowly to 39° in midwinter. There is some evidence that the larvæ can withstand low temperatures, and Swenk (1909, p. 334) cites a case where they survived a twelve-hour exposure to a sweeping wind of from 59 to 72 miles an hour velocity, with the temperature about zero.

Like most of the species of the genus, the adults of *opaca* are negatively phototropic to strong light. During the day they are usually to be found hiding under various types of shelter, confining most of their activities to the early morning, evening, and night. The larvæ

are subterranean in their habits, and when placed on the surface of the ground they immediately burrow into the dirt.

Control

Thus far it has not been possible to carry out any extensive experiments on the control of *Eleodes opaca* in the field. The measures advocated are based on a study of the history of over 200 infested fields obtained through personal visits, and from questionnaires furnished to the farmers. In most cases the history of the field has been obtained for the preceding two or three years. A study of the data thus secured suggests several promising methods of procedure which have proved beneficial in controlling or reducing the amount of injury.

Rotation.—The investigations in many fields infested by false wireworms show that in nearly all cases the greatest injury has occurred on land continuously cropped to wheat, while fields that have been in a row crop or fallowed previous to wheat have suffered little damage. The beetles are wingless, and migration from field to field must take place on foot. These facts indicate that a careful rotation of crops, combined with certain other practices to be mentioned later, would eliminate much of the damage and the writer has seen many fields where this has been the case. In following a system of rotation in western Kansas, it must be remembered that the number of crops that can be alternated with wheat is limited principally to feed crops such as sweet sorghums, kafir, milo, and feterita, and, under certain conditions, corn. Occasionally oats and barley are included, and many farmers practice a rotation whereby a small grain crop is planted early in the spring on land where the worms have destroyed the wheat crop the previous fall. Such a system usually increases the injury since it provides additional food at a time when the larvæ are maturing. Where the fall wheat has been destroyed, the land should be worked about the first of May and planted to a row crop. If the field is kept cultivated and free from weeds and grasses, it is often possible to return the land to wheat in the fall. This is not always feasible, since the feed crops are late maturing, and in this case oats or barley should be planted in the spring to be followed by wheat in the fall. Call and Salmon (1918, pp. 42–43) suggest the following rotation for western Kansas: wheat two years; kafir or other sorghums, one year; and summer fallow, one year. By this system, one-half of the farm is in wheat each year, one-fourth in a feed crop, and one-fourth is fallowed for the next wheat crop. Such a system, if carefully followed, would reduce the false wireworm injury and at the same time increase the yield.

Summer Fallow.—The practice of summer fallow whereby the land lies idle for a year, being worked sufficiently to keep down the plant

growth, is practiced to a limited extent in western Kansas. Where this method is followed there has been little or no injury from false wireworms. Summer fallowing deprives the beetles and larvæ of food, and destroys many eggs. The beetles are also deprived of shelter during the day. This method of handling the wheat land is somewhat more expensive than the usual methods, but the yields are generally ample to encourage its use.

Weeds and Volunteer Crops.—During the summer months, large numbers of adults are to be found hiding under Russian thistles and in clumps of volunteer wheat and oats in the fields. The keeping down of these plants will deprive the beetles of shelter, and cause them to seek protection elsewhere, and will also serve to deprive the larvæ and adults of food. Heavy growths of weeds and grasses along the roadsides and fence rows should also be kept down during the summer.

Time of Planting.—Some injury can be avoided by delaying the planting of wheat in the fall, although as a rule late planting does not yield as well as early sowing. The larvæ usually ceased their activities during the latter part of October, and wheat planted after the middle of this month will be less subject to injury. With regard to the time of planting, it might be stated that with favorable conditions, such as a well-prepared seedbed, good seed, and plenty of moisture, seeding may be made moderately early. On the other hand, if the season is dry and the seed may lie for some time in the ground before germinating, it is advisable to delay the planting. The larvæ are most active in a dry, loose soil, and the greatest injury has occurred in those years when the summer and fall have been dry.

In the case of spring crops, planting should be delayed until about the first of May, at which time most of the larvæ have reached maturity and are transforming to pupæ. This is especially to be recommended when the crop is to be planted on land where the wheat has been destroyed by the worms.

Spring Plowing.—The practice of plowing or listing infested fields early in May will destroy large numbers of pupæ by breaking up the pupal cells, and crushing the pupæ or by exposing them to natural enemies and climatic conditions. The writer has been in many fields where this has been done, and in every case from 80 to 95 per cent of the pupæ were destroyed. This method can be followed where the larvæ have destroyed the wheat and it is planned to plant sorghums or corn.

Stacking vs. Shocking.—Examinations made in fields where the previous wheat crop was shocked often show more injury than where the crop was stacked. In other words, the shocks provide shelter for the beetles in all parts of the field, and instead of the outbreak being

confined to one part of the field, it is general over the entire area. When the grain is stacked at harvest, the infestation often radiates out from the stack, indicating that the beetles have congregated there.

Poison Bran Mash.—The use of the poison bran mash as prepared for use against grasshoppers may prove beneficial in some cases in the control of *Eleodes opaca*. Under laboratory conditions the beetles ate it voraciously, and were attracted to it from a distance of two or three feet. The possibility of its use under certain conditions where the adults are congregated in large numbers around wheat shocks and stacks, and piles of Russian thistles may prove practical. Experiments in poisoning the larvæ have thus far given negative results.

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EXPERIMENTS WITH POISON BAITS AGAINST GRASSHOPPERS[1]

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During the past season grasshoppers were abundant and caused considerable damage to clover, alfalfa, tobacco and other crops in the vicinity of southern Wisconsin. Especially were they abundant in

[1] Published by permission of the Secretary of Agriculture.

the vicinity of Janesville, where the writer was temporarily located, and where conditions afforded an opportunity to test different combinations of poison bait under varying climatic conditions. The results thus obtained indicate that certain changes in the present standard formula might be made to advantage, that climatic conditions play an important rôle in the efficacy of poison baits, and that mature and immature grasshappers are attracted to odorous baits unequally.[1] While the results are not conclusive and do not warrant changes in recommendations, they show definite tendencies which we believe should be taken into consideration by entomologists who contemplate grasshopper experiments a following season.[2]

Attractiveness of Different Baits

In one series of four experiments made August 29, to determine the relative attractiveness of various baits, fifteen combinations based upon the standard formula (bran, fruit, molasses, water and poison) were tried, but each contained a different attractive element. These experiments were conducted simultaneously at four points in an equally infested field of barley stubble, each at least a quarter of a mile apart. The baits were placed in small piles, containing about half a handful, six feet apart, and the application completed by 7 a. m. Observations were made at half-hour intervals from 8 a. m. until 3 p. m., and include a record of the number of grasshoppers and crickets either actually feeding, or within a radius of six inches of the pile.

The combined results of these experiments are as follows: apples alone, 71 hoppers and 37 crickets; molasses and bananas, 53 hoppers and 30 crickets; molasses alone, 52 hoppers and 48 crickets; bananas alone, 46 hoppers and 23 crickets; salt alone, 45 hoppers and 33 crickets; molasses and apple, 40 hoppers and 30 crickets; lemon fruit, 38 hoppers and 25 crickets; lemon extract, 38 hoppers and 41 crickets; molasses and salt, 32 hoppers and 14 crickets; molasses, salt and lemon extract, 31 hoppers and 40 crickets; molasses, salt, and lemon fruit, 31 hoppers and 30 crickets; salt and bananas, 27 hoppers and 35 crickets; molasses and lemon extract, 20 hoppers and 34 crickets; with molasses, salt and apple coming last in this series with a total in three of the four experiments of 19 hoppers and 5 crickets. This last observation of apple with salt and molasses is not comparable with the other results for in one experiment this bait was omitted by mistake, and

[1] In the vicinity of Janesville, Wis., *Melanoplus femur-rubrum*, *M. atlanis*, and *M. bivittatus* predominated, and nearly all were nearly mature at the time of the experiments.

[2] The writer wishes to acknowledge suggestions and kindly criticism received from J. J. Davis.

also because in one of the three experiments in which it was used it was placed in a slight depression which undoubtedly gave an unfair result.

A single earlier experiment on August 22, using ten baits under similar conditions but in another part of the same field gave the following results: apple, molasses and salt, 14 hoppers and 6 crickets; apple and molasses, 13 hoppers; molasses alone, 8 hoppers and 4 crickets; apple alone, 7 hoppers and 1 cricket; lemon extract alone, 7 hoppers and 1 cricket; lemon fruit and molasses, 6 hoppers and 1 cricket; banana alone, 6 hoppers; molasses, lemon extract and salt, 6 hoppers; salt alone, 3 hoppers; lemon extract and salt, 2 hoppers.

The above observations are summarized in the following table:

Summary of Results of Attractiveness Experiments

Exp. No.		No. Hoppers	No. Crickets
1.	Bran Apple	7	1
2.	Bran Banana	6	
3.	Bran Lemon extract	7	1
4.	Bran Salt	3	
5.	Bran Salt Lemon extract	2	
6.	Bran Molasses	8	4
7.	Bran Molasses Lemon	6	1
8.	Bran Molasses Apple	13	
9.	Bran Molasses Salt Lemon extract	6	
10.	Bran Molasses Salt Apple	14	6
11.	Bran Molasses	52	48
12.	Bran Lemon	38	25
13.	Bran Lemon extract	36	41
14.	Bran Apple	71	37
15.	Bran Banana	46	23
16.	Bran Salt	45	33
17.	Bran Molasses Lemon	31	23
18.	Bran Molasses Lemon extract	20	34
19.	Bran Molasses Apple	40	30
20.	Bran Molasses Banana	53	30
21.	Bran Molasses Salt	32	14
22.	Bran Molasses Lemon Salt	31	30
23.	Bran Molasses Salt Lemon extract	31	40
24.	Bran Molasses Salt Apple	19	5
25.	Bran Molasses Salt Banana	27	35
	Total number recorded	644	461

These experiments indicated that apples and bananas when used alone or with molasses are as attractive or slightly more so than lemon fruit or lemon extract.

Actual control experiments testing these various combinations all gave satisfactory results with mortalities varying from 60 to 98 per cent. In a series of baits sown on August 20, one containing apples and molasses gave, at the end of five days, an average count of 40 dead hoppers to the square yard, or approximately 75 per cent. A bait containing lemon fruit and molasses, but sown in an area containing a

slightly heavier infestation gave an average of 50 dead hoppers to the square yard or approximately 75 per cent. Lemon fruit and salt gave practically the same results as molasses and salt with average square yards showing from 35 to 40 dead hoppers or about 70 per cent. In this series salt alone resulted in an average of 30 dead hoppers to the square yard or about 65 pér cent, while molasses alone gave 28 dead hoppers to the square yard, or about 60 per cent.

These experiments further show that apples and molasses gave practically the same results as lemon fruit and molasses; that lemon fruit and salt gave practically the same results as molasses and salt, but that both were slightly less effective than the first two combinations. Salt alone seems to have given slightly better results than molasses alone.

Another series on September 3 resulted in banana alone obtaining a kill of 35 to 40 hoppers to the square yard or approximately 85 per cent, while apple alone resulted in from 25 to 30 dead to the square yard, or about 75 per cent. Molasses alone, at the usual rate, gave 48 dead to the square yard, or approximately 90 per cent, while molasses alone, at double strength, but sown in standing corn, gave a kill of 15 to 20 hoppers to the square yard, or 85 per cent of the infestation.

Grasshopper injury to tobacco shows up as holes in the tobacco leaves. This makes the tobacco useless as binder tobacco and results in a very low price for the crop. Since a small infestation can in a very short time eat holes in a considerable amount of tobacco, the use of something which will give a quick and maximum kill means a considerable saving. In several experiments bananas were substituted for the lemon fruit in the standard bait, applications being made under similar conditions and in all cases the banana gave as good results as the lemon fruit and seemed to give a heavier early mortality. This indicates that banana might be of special value when treating tobacco which, this year in southern Wisconsin was estimated as being worth $450 an acre.

Period of Attractiveness of Different Fruits

One marked difference between the citrous and non-citrous fruits, such as apples and bananas, is that citrous fruits become flat within a day or two after application, whereas the non-citrous fruits mentioned above increase in odor and attractivensss as fermentation progresses. This factor should make baits attractive for more than the one or two days during which the citrous baits are effective. Grasshoppers and crickets have been observed feeding upon the non-citrous baits as late as the eleventh and twelfth days after application, although no hoppers could be found at that time feeding upon the citrous baits

which had been sown at the same time. If, as is sometimes the case with citrous baits, an efficient kill has not been obtained within a few days, the materials and labor represent an almost complete loss, whereas with non-citrous fruits the odor becomes stronger, and even when the bait has been completely dried out, a slight mist or dew will cause the non-citrous baits to again become odorous and attractive, and consequently not a complete loss, even though the initial kill had not been high.

Relative Attractiveness of Mature and Immature Grasshoppers to Odorous Baits

As the majority of the grasshoppers recorded in these experiments were adults, the question arises as to whether these baits would prove equally effective against immature grasshoppers. The writer's observations seem to show that the younger hoppers are much more susceptible to a highly odorous bait. In three control experiments on July 23, at which time a considerable portion of the hoppers were in the third and fourth instar, a very efficient kill was obtained by the addition of half an ounce of lemon extract to the standard formula. It was originally intended to use the lemon fruit alone, but the lemons did not make the mixture especially odorous so the extract was added. This gave a very efficient kill of from 85 to 90 per cent of the infestation.

In comparison with the above we have the results of four experiments on August 6, under approximately the same conditions. Here lemon fruit was used in the standard bait at the rate of five fruits to 25 pounds of bran. The hoppers were still in the third and fourth instars with a few adults. The results from these experiments show not more than a 65 per cent mortality, and this included mostly fourth instar and adult hoppers. This difference in efficiency compared with the earlier experiment, which gave a 90 per cent mortality, is marked and would indicate that young hoppers responded better towards the more odorous bait. This suggests that there may be considerable variation between the attractiveness of a certain bait to the younger in comparison with the more mature hoppers. It is believed that had lemon extract been added to the bait in this second series the results would have been much more efficient.

Effect of Climatic Conditions on the Efficiency of Poison Bait

A rather low temperature and a high humidity such as one finds immediately after a storm, appears to be ideal for a rapid and maximum mortality. In one experiment an application of four different baits, containing three different poisons, was made following a night of heavy

rain and wind, with considerable thunder and lightning. The rain ceased about 4.30 a. m. and the application was made at 5 a. m. At that time the temperature was 61° F. and the humidity 96 per cent. The average temperature for the five days following the application was 69.34° F. compared to a monthly average of 74.85° F. The average humidity for the period was 77.2 per cent compared to the monthly average of 73.93 per cent. The daily average atmometer reading for the period was 9.66 cc. compared to an average for the month of 24.58 cc. The application covered about 20 acres, five of which were in tobacco. About one third of the tobacco had been so severely injured that only the stalks and stems remained. At the end of the two days following the application the mortality was found to have reached as high as 90 to 95 per cent. At the end of the five-day period it had increased to from 95 to 98 per cent. The dead hoppers averaged from 135 dead to a square yard in the pasture and stubble, to 51 to the square yard in the tobacco. Practically no live hoppers could be found.

It was also noticed that whenever an application was made on a hazy or cloudy morning, which cleared either late in the morning or early afternoon, that a quick and highly efficient kill was obtained.

One very unusual result was noted in a successful control where a shower came on while the application was being made, and which was followed that night by a heavy rain. Ordinarily one would expect but a very slight kill under such conditions. At the end of two days not more than three or four dead hoppers could be found to a square yard anywhere in the treated area. At the end of five days conditions were practically the same. On the eleventh day the writer, in passing through the field, noticed that dead hoppers were much more abundant than when previously examined. A careful examination showed approximately 20 dead hoppers to the square yard over the entire treated area, which in this experiment covered about 60 acres. Compared to the original infestation, there were at least 85 per cent of the insects dead.

Comparative Value of Different Arsenicals

Paris green was the popular poison in use at Janesville and consequently when poison bait was recommended or used as a control, Paris green was used. However, when the writer helped make an application he often used crude arsenious oxide, for at least part of the application. On some 34 control experiments Paris green was used 12 times, crude arsenious oxide 18 times, and calcium arsenate 4 times. Wherever crude arsenious oxide was used side by side in a direct comparison with Paris green, as was the case in six experiments, in which applica-

tions covered approximately 65 acres, very little choice could be found. Apparently both worked with nearly the same rapidity and were equally effective. The coarse grade of arsenious oxide was a little hard to handle, making a very careful mixing necessary. The lack of color also means that more care must be used to insure an evenly mixed bait. Calcium arsenate was used in four experiments in direct comparison with both of the above, and in all four gave good results. It was noted that it was not as rapid a poison as the others but the hoppers were made sick and apparently did no further injury. At the end of the five-day period, however, the mortality resulting from each of these three poisons was nearly the same. In treating tobacco, Paris green caused some leaf burn while calcium arsenate did not.

Rate of Application

It was found in many cases, and especially so when there was any amount of vegetation in the field, that the use of the standard poison bait at the rate of 25 pounds for five to seven acres was not heavy enough to secure maximum results. This appeared to be due to the weakness of the odor of the standard bait. However, an addition of lemon extract to the standard formula made a much more odorous bait, and proved effective at the usual rate of application, while the standard bait when used at the rate of from six to eight pounds to the acre, gave efficient results. The use of lemon extract alone depends greatly upon the strength of the extract. One extract which was tried, and which did not give results, was found to be what was called a 2 per cent extract. Druggists' extracts were found to be at least a 5 per cent extract, and will run as high as 10 per cent.

It appears that the rate of application should depend upon the infestation and the attractiveness of the bait.

THE VALUE OF CRUDE ARSENIOUS OXIDE IN POISON BAIT FOR CUTWORMS AND GRASSHOPPERS[1]

By John J. Davis, *West LaFayette, Indiana*

Last winter (January, 1918) Mr. W. R. Walton submitted samples of a finely powdered crude arsenious oxide from a Montana copper smelter company to determine its effectiveness against cutworms and grasshoppers when used in bran bait as a substitute for Paris green. It was tested indoors with army worms (*Cirphis unipuncta*) and the results

[1] Published by permission of the Secretary of Agriculture.

which warranted further tests in the field were published recently in the *Canadian Entomologist*.[1]

The past spring a barrel of crude arsenious oxide was obtained from the same Montana smelter and samples were sent to entomologists in various parts of the country for testing. Unfortunately, the material was of a coarser and more granular grade than desired but the mistake was found too late to obtain another supply.

Most of those receiving a supply have furnished us with a summary of their results and they are briefly as follows:

C. N. Ainslie, Sioux City, Iowa. Did not have an opportunity to test material. However, he states that farmers of western South Dakota used car loads of arsenic obtained from the Montana smelters and with good results against grasshoppers.

G. G. Ainslie, Knoxville, Tennesse. Did not have an opportunity to test material.

C. W. Creel, Forest Grove, Oregon. Did not have an opportunity to test material.

S. E. Crumb, Clarksville, Tennesse. Did not test in field but results in laboratory experiments with cutworms gave the following results:

Coarse	Crude	Arsenious	Oxide,	1–96	15 %	dead	5th	day		1	test
"	"	"	"	1–48	49 %	"	"	"	Av.	5	tests
"	"	"	"	1–24	79+%	"	"	"	"	4	"
Powdered	"	"	"	1–72	87+%	"	"	"	"	2	"
"	"	"	"	1–48	97−%	"	"	"	"	3	"
"	"	"	"	1–24	97−%	"	"	"	"	3	"
Paris green	"	"	"	1–96	95 %	"	"	"	"	5	"

Mr. Crumb concludes that the powdered grade will prove satisfactory against cutworms in the field at 1 to 50 pounds of bran and that a dosage of 1–25 can certainly be safely recommended.

Geo. A. Dean, Manhattan, Kansas, found the crude arsenious oxide furnished not quite as efficient as other poisons when used against grasshoppers but believes this due to coarseness and that if ground as fine as white arsenic or Paris green it would be an excellent substitute and equally as good.

W. P. Flint, Springfield, Illinois. Mr. Flint writes: "I used the crude arsenious oxide as a grasshopper poison, using it at one half the amount of Paris green and applied it in the same manner, with bran, fruit, and syrup, with practically the same results in the two fields where tested. E. M. Schalck tried it in the northern part of the state and he reports as good results or a little better than Paris green. I had some trouble because of coarseness of material, it sometimes taking an hour or an hour and a half for the lumps to dissolve."

[1] Davis, J. J., and Turner, C. F. Experiments with cutworm baits. In *Canadian Entomologist*, vol. 50, No. 6, June, 1918, pp. 187–192.

L. G. Gentner, Madison, Wisconsin. Did not have an opportunity to test material.

Arthur Gibson, Ottawa, Canada. Only preliminary cage tests made which do not warrant definite conclusions.

J. R. Horton, Wichita, Kansas. Mr. Horton used the crude arsenious oxide in bait against mature grasshoppers in a wheat field, the first application being made October 7, using at the rate of seven pounds bait per acre. The regulation formula of bran, poison, molasses and lemon fruits was used, the poison and bran at the rate of 1 to 25. This application killed 74 per cent of the grasshoppers. A second application on the same area October 15, with bait prepared and applied as the first, gave 88 per cent killed, calculating the number of grasshoppers alive after the first poisoning as 100 per cent. The percentage killed by both poisonings was 96.9 per cent and Mr. Horton adds, "almost the only hoppers to be found were dead."

Philip Luginbill, Columbia, South Carolina. Did not have an opportunity to test the material.

G. I. Reeves, Salt Lake, Utah. According to Mr. Reeves the farmers of Utah use arsenious oxide, obtained from the nearby smelters, quite extensively in making poison bran mash.

D. A. Ricker, Janesville, Wisconsin. In his field tests with poison baits against grasshoppers, Mr. Ricker made comparative tests with Paris green, calcium arsenate and the crude arsenious oxide. He reports that he found little choice between Paris green and the crude arsenic as far as effectiveness and rapidity of killing was concerned. Calcium arsenate seemed effective but was a slower acting poison.

W. B. Turner, Hagerstown, Maryland. Did not have an opportunity to test the material.

T. D. Urbahns, Berkeley, California. For grasshoppers, Mr. Urbahns found Paris green and crude arsenious oxide about equally effective. He adds, however, that "the crude arsenious oxide was found more difficult to mix on account of settling to the bottom in the liquid" and that the same difficulty is more or less true with white arsenic.

R. A. Vickery, San Antonio, Texas. Did not have an opportunity to test the material.

R. L. Webster, Ames, Iowa. The sample was tested by C. A. Burge, County Agricultural Agent at Greenfield, Iowa, who reported to Mr. Webster under date of October 9, 1918, as follows: "In regard to the poison for grasshoppers made with crude arsenious oxide which was used at the farm of H. P. Proctor in this county, Mr. Proctor informed me yesterday that he obtained only fair results. Mr. Proctor thought if the arsenic could be soaked over night in water so as to dissolve the granules the results obtained might be better."

Don B. Whelan, East Lansing, Michigan. Mr. Whelan reports crude arsenious oxide to be as effective against grasshoppers as Paris green when used at the same strength, the formula used being one pound of poison, one bushel of sawdust, one scant pound of salt and one cup of molasses with water as needed. Mr. E. E. Twinge, County Agricultural Agent of Kalkaska County, Michigan, used a barrel of this crude arsenious oxide (coarse, granular grade) and obtained results generally favorable as to its efficiency against grasshoppers but he does not believe it gives as good satisfaction as white arsenic, of which several tons were used in Kalkaska County. This may have been due to the coarseness of the crude arsenic. The formula given by Whelan and noted above was used.

V. L. Wildermuth, Tempe, Arizona. Under date of October 18, 1918, Mr. Wildermuth writes, "We tried the crude arsenious oxide against grasshoppers on three different occasions and were not at all satisfied with the results." He adds that the earlier sample furnished by Mr. Walton, which was a finely powdered material, proved quite satisfactory and gave excellent results and concludes that a powdered grade would be quite more desirable than Paris green, chiefly because of its cheapness and equal effectiveness.

Our own experience with crude arsenious oxide has shown it to be quite satisfactory against cutworms, army worms, and grasshoppers, and in some cases it seemed to be even more effective than Paris green but when using the coarse, granular grade we experienced the same difficulty noted by othes. We also found the bait almost as effective when half sawdust was substituted for bran.

From the above work conducted in various parts of the continent we conclude that crude arsenious oxide is a satisfactory and reliable substitute for Paris green at about one seventh the cost but that a powdered grade only should be recommended. The one advantage of Paris green over powdered arsenious oxide is its color which simplifies the mixing and makes possible an unquestionable thorough mixture.

SOME NOTES ON PHORBIA FUSCICEPS AS A BEAN PEST

By I. M. Hawley[1]

In the spring of 1917 the bean crop in New York State was seriously damaged by the seed-corn maggot (*Phorbia fusciceps* Zett). In five townships of one county there was a loss of $15,000 for seed destroyed by the insect, and in another county the loss on 16,000 acres planted was estimated to be between 50 and 75 per cent.

[1] Contribution from the Entomological Laboratory of Cornell University.

The damage is caused by the maggots in the ground when the beans are planted. As the bean swells on sprouting, the larvæ eat off the plumule or tunnel in the fleshy cotyledons. The beans often develop into stunted plants, known as snake heads, (Pl. 9), which do not mature and produce pods. If the cotyledons are above ground before the maggots find the plant, the stem beneath the ground is attacked. After eating its way to the pithy center the larva mines upward an inch or more.

There are two broods of flies each year in western New York and the writer believes that in some years there is a small third brood. The first flies emerged early in May in 1918 and there was a second brood during the last half of June and the first part of July. The time from egg to adult for bred specimens has varied between 25 and 47 days.

Flies emerging in May are attracted for feeding and oviposition to moist, freshly-plowed ground. The writer has found a few eggs on newly turned soil and obtained others by throwing pails of water on the ground around the laboratory. Several hours after the water was thrown out eggs were found in these moist spots, though none could be found in dry places. Eggs have also been found in large numbers around decaying bean vines as well as rotting cabbage and clover roots, and Prof. R. H. Pettit (in correspondence) reports breeding flies from fresh manure and decayed clover stems.

Many times in the literature reference has been made to decaying material as a breeding place for the maggots of *Phorbia fusciceps.* Schoene[1] reports finding the larvæ with those of *Phorbia brassicæ* in cabbage-heads and when so found, they were in the decaying part of the plant. In examining bean fields, maggots have been found in healthy plants, although they are found in much larger numbers in beans which have begun to decay. As high as seventeen maggots have been found in one rotting bean.

If beans are planted when the ground is cold and wet, and the growth is slow and decay sets in, maggots will be attracted from their feeding places on buried clover roots or other decaying material to the beans in large numbers. This influence of cold rainy weather on the growth was demonstrated in the spring of 1917 when the rainfall at Rochester, N. Y., in the bean-growing section of the state was 6.40 inches from June 1 to July 1. Many growers lost their entire crop. In 1918 the rainfall for this same period was 2.40 inches and on the whole a fine stand of beans was obtained.

The writer had hoped to find some material which applied to the beans before planting would either repel the maggots or kill them as they fed on the cotyledons. However, anything placed on the seed-

[1] Journ. Econ. Ent. Vol. 9., p. 132.

1, Work of *Phorbia fusciceps* in beans soon after planting; 2, Stunted bean plants or "Snake heads"; 3, "Snake heads" sending out new leaves; 4, A plant developed from a "Snake head" compared to a healthy plant of the same age.

coat will be shed with it as the bean swells and the plant is again unprotected. At germination the bean is very sensitive to most insecticides and many things applied proved harmful to the growth. For these reasons and because it is usually impossible to predict an outbreak of maggots for experimental work, nothing of material value had developed up to the present time.

Professor Pettit as the result of work in Michigan believes that clover or alfalfa sod, fertilized with fresh manure and turned under just before planting to beans, makes the most favorable condition for serious injury, and advises the use of old manure or other fertilizer and that the ground be allowed to lie idle for awhile before planting. As the common rotation in western New York is to follow clover with beans and wheat, clover roots are often present for maggots to work on before entering the beans. If, as seems to be the case, eggs are laid at plowing or fitting time, and the ground is left fallow for about two weeks until the maggots present have pupated, beans may then be planted with safety. If the first seeding is destroyed, it is wise to delay replanting for a week or two until the maggots have pupated. In late seasons this may be impossible, and in that case it is better to substitute some other crop. Buckwheat is often used for this purpose in New York. Plowing the preceding fall or early in the spring before most of the flies appear should also tend to cut down the infestation.

In 1917 it was often observed that shallow planted beans were less damaged than those planted deeper. One grower started planting with a bean planter which placed the seed just beneath the surface of the ground, and then fearing that he was not putting them in deep enough he used a grain drill which buried the beans to a depth of three or four inches. At harvest time he had a good stand on the part where the planter was used, but the rest of his field was a total loss. The bean planter is now coming into greater favor because it is lighter and does not sink in so far in wet spots and so it is more easy to regulate the planting depth. Many growers are now putting the beans in so shallow that a boy is sent along to cover those left on the surface.

If a bean gets above the ground quickly, the chance of escaping the attack of *Phorbia fusciceps* is much better. Shallow planting, a judicious use of a quick acting fertilizer with an excess of seed will tend to increase the yield in wet seasons. Drilling beans deep in wet soil will surely result in a loss.

NOTES ON SOME LITTLE KNOWN PESTS OF RED-CLOVER

By Glenn W. Herrick and J. D. Detwiler

During the past few years, a more or less continuous study of the insect pests of red clover has been carried on at Ithaca. Interruptions have occurred from time to time but a special effort was made last season by the writers to continue the investigation. It seemed that a study of clover insects in New York was of special significance in time of war. Clover is the principal crop in the northern states for the maintenance of the fertility of the soil and upon it, in great measure, depends the production of farm crops in a continuously average amount. Therefore any measure that will conserve clover and especially clover seed is of direct aid in a food crisis of this country. With this thought in mind the writers made special effort during the past summer to investigate the life-histories and injuries of three little known pests of red clover that occur abundantly in the vicinity of Ithaca. These are the lesser clover-leaf weevil, *Phytonomus nigrirostris*, the clover-head weevil, *Phytonomus meles*, and the clover tychius, *Tychius picirostris*.

The infestation of the first two species could hardly be considered severe as counts of infested and uninfested heads show. On June 29 a count was made of a total of 400 heads. Of these 6 per cent of the ripened heads, 1.8 per cent of those in bloom, while 7+ per cent of the immature heads were found infested. On July 1 another lot of heads, a total of 340, gathered near the border of a clover plot were examined for the presence of the weevil. Of these 21 per cent of the mature heads, 4 per cent of those in bloom, and 2.2 per cent of the green ones were found infested. In this case the percentage of infestation in the mature heads was highest. Again on July 2 a count of 403 heads was made. Of these 7 per cent of the ripened heads, 3 per cent of those in bloom, and 2 per cent of the green heads were infested. Here also the highest infestation was among the matured heads.

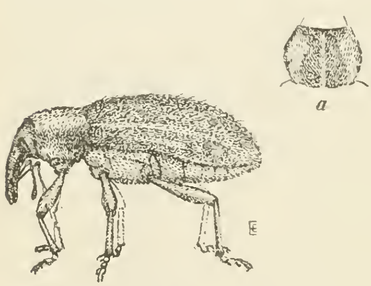

Fig. 8. *Phytonomus nigrirostris; a.* Thorax.

The Lesser Clover-Leaf Weevil, *Phytonomus nigrirostris* Fab.

This weevil (Fig. 8) was found in considerable abundance in clover fields at Ithaca. The larvæ were at work in immature heads, in those in bloom, and in those that had ripened. During the last days of June when this investigation began, larvæ and pupæ, and empty co-

coons were present in the heads of clover, the empty cocoons showing that some beetles had already emerged.

Those larvæ that live in the heads of the clover tunnel into the head and eat into the florets a short distance up from the bases and apparently devour the ovaries, thus preventing the development of seed. It is seldom that more than one larva is found in a head but this one destroys several florets. The larvæ of this beetle also work in the axils of the clover stems. In one small plot of clover the larvæ were quite numerous in the axils of the stems and committing considerable injury. The larva eats into the sheath surrounding the bud in the axil, severs the bud from the stem, and eats out a groove in the side of the main stem. Further investigations are necessary to determine the amount and seriousness of this injury.

During the latter part of June and the first part of July the larvæ became full grown. Many of them had already spun cocoons by June 29 and from some cocoons the beetles had emerged. The lacelike cocoons are found in the heads of the clover, often at the base of the head. The following table contains data on the length of the pupal stage:

Duration of Period in Cocoon

Date of Spinning Cocoon	Emergence of Beetle	Period in Cocoon, Days
June 27	July 13	16
June 29	July 13	14
July 6	July 19	13
July 12	July 25	13

On June 28 a number of larvæ were placed in a cage with clover. On July 2 one cocoon was found and by July 4, eight had spun cocoons. The first beetle emerged July 16, another July 17, and a third July 18. From the foregoing data it is apparent that the time spent in the cocoon varies from 13 to 16 days, probably varying with the individual and the temperature.

The Clover-Head Weevil, *Phytonomus meles* Fab.

This is a foreign weevil that has apparently been recently introduced into this country, probably from Europe. It is said to occur widely over Europe and is also found in parts of Asia and along the north coast of Africa. In this country it has been found in New Hampshire, Massachusetts, Connecticut, New Jersey, and New York. Apparently it was first noted in New York in 1907. During the past season this weevil was abundant in red clover fields in the vicinity of Ithaca and was evidently contributing to the general insect injury to this plant.

The beetle is from one seventh to one fifth of an inch in length and, in general, of a grayish or greenish-brown color. The specimens reared by us are distinctly striped with longitudinal lines of light brown scales near the lateral edges of the elytra. The thorax has two wide, dark longitudinal dorsal stripes separated on the median line by a narrow golden-brown stripe (Fig. 9). The thorax is wider than long and markedly rounded on each side while the thorax of *P. nigrirostris* is longer than wide and less rounded on the sides (Fig. 8, a).

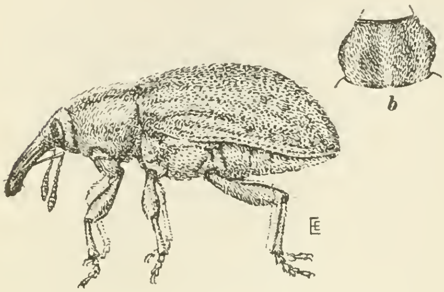

Fig. 9. *Phytonomus meles; b*, Thorax.

Our studies began too late in the season to find the eggs but Titus has found them deposited on and in the stems, and leaf petioles of clover and alfalfa and on blossoms of clover. The larvæ were present in abundance however in the heads of clover. The larvæ probably spin their cocoons in the field on the heads of clover, often between the bracts on the head and probably also in the axils of the branches. All of the cocoons observed were formed in the laboratory under abnormal conditions but their positions indicate that they would be placed in the field as suggested. The pupæ are interesting from their conspicuous and active movements in their cocoons. In one instance a pupa was formed which had not been able for some reason to spin its cocoon. The violent and rapid movements of this pupa when disturbed seemed quite remarkable. Moreover, the same movements of the pupæ within the cocoons were repeatedly noted. The following table presents data on the length of the cocoon stage:

Duration of Period in Cocoon

Date of Spinning Cocoon	Emergence of Beetle	Period in Cocoon, Days
July 2	July 21	19
July 2	July 18	16
July 4	July 18	14
July 5	July 19	14
July 6	July 19	13
July 10	July 23	13
July 10	July 22	12

It will be seen from the foregoing table that the time spent in the cocoon varies from 12 to 19 days, the period apparently growing shorter with the advancing season.

The Clover Tychius, *Tychius picirostris* Fab.

The clover Tychius is a small grayish snout-beetle only about one tenth of an inch in length. It is known in Europe, according to Blatchley and Leng, as *Miccotrogus picirostris,* and there it lives in the capsules of red clover, and on plantain and *Genista.* The beetle is certainly widely distributed in New York State. Knight has found it abundant especially on pear trees and Casey reports it "in extraordinary numbers at Lake Champlain." Felt reports it from Waterville, New Baltimore, Albany, Newport, Speculator, Gouverneur, Oswego and McLean. Outside of New York it has been taken in Maine, New Hampshire and Massachusetts. In Canada, Du Porte records it in large numbers in nearly all fields of common red and mammoth red clover in the vicinity of Ste. Anne's, Quebec. Here the adults were feeding gregariously on the leaves while later in the season they attacked the flower heads of clover.

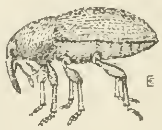

Fig. 10. *Tychius picirostris.*

Here at Ithaca we find it abundantly in fields of red clover. As many as nineteen adults were found in a newly opening head of red clover. The beetles apparently feed upon the pollen of the florets. In a count made 90 per cent of the florets were punctured and in most of these the anthers were shrunken and discolored.

The larvæ are white and only about 2 mm. in length and are found living in the clover heads where they apparently feed upon the florets. They were found in abundance during July and through the month of August. The insect is undoubtedly capable of doing considerable damage. When the larvæ are full-grown they go into the soil and there form cells apparently by cementing grains of soil and sand firmly together. The summer brood of beetles began appearing about the middle of August. We can say nothing yet as to the mode of passing the winter or as to the eggs or place of deposition. It is hoped that the investigations may be continued during the coming season.

The writers wish to make acknowledgement to Miss Ellen Edmonson for the drawings of the three species considered.

European Corn Borer. A subcommittee on the pest has been appointed by the Chairman of the Committee on Policy of the American Association of Economic Entomologists. It consists of E. P. Felt, Chairman and Messrs. Herbert Osborn and J. G. Sanders and is charged with all phases of the problem which might properly come within the province of representatives of a national organization.

THE DISPERSION OF FLIES BY FLIGHT[1]

By F. C. Bishopp and E. W. Laake, *U. S. Bureau of Entomology*

Abstract

Up to very recent years it has been generally held by entomologists that flies are comparatively limited in the distances which they will go from breeding places. Dr. Parker's work in Montana indicated that the house-fly is normally migratory in habit and he succeeded in obtaining specimens nearly two miles from the point of liberation. In 1916 the authors conducted some preliminary experiments in which colored flies were liberated in the vicinity of packing houses and a considerable number of these were recovered quite promptly in traps placed in the yard of the packing establishments, a flight of about three-fifths of a mile. The flies liberated in this experiment consisted largely of blowflies of the species *Chrysomyia macellaria* and *Phormia regina*. Later in the same summer a series of experiments was carried out to determine the distance of flight of several species of blowflies and house-flies under rural conditions. The flies were liberated at a point near the intersection of two roads and four traps were placed at given distances in the four cardinal directions from the point of liberation. A total of 1,745 colored flies were recovered in the sixteen recovery traps and a considerable number of these were in the outer ring of traps which was approximately three miles from the point of release. Another experiment was conducted immediately following this in which the traps were moved outward in the four directions to points approximately 2, 3, 4 and 5 miles from the point of liberation. House-flies, screw-worm flies and the Anthomyid, *Ophyra leucostoma*, were recovered in some of the most distant traps.

In 1918 it was determined to make more extensive tests of the dispersion tendencies of various species of flies. The same general plan was followed as in the previous experiment, four traps being set in each of the cardinal directions from the point of liberation at distances approximately 4½, 6, 7 and 8 miles. About 60,000 colored flies were liberated, approximately 58 per cent being screw-worm flies, 39 per cent house-flies and the remainder *Phormia regina*, Sarcophagids and other species. As in previous experiments the flies in the various traps were killed daily and examined carefully for marked individuals. The day following liberation a considerable number of marked house-flies and screw-worm flies were recovered in several of the traps. Even in those located 8 miles in each direction from the point of release, some screw-worm flies were taken. Following this experiment the traps were removed

[1] Published by permission of the chief of the Bureau of Entomology.

to points east and west approximately 9½, 11, 13, 15 and 17 miles, two traps to the north 13 and 17 miles, and two traps to the south 8 and 10 miles from point of release. A trap was also placed about 7 miles east of south and another about 10 miles south of west of the point of liberation. About 80,000 flies were released in this test. The greatest distance from the point of liberation at which marked flies were recovered was: House-flies, 13 miles; screw-worm flies, 15 miles; *Phormia regina*, 11 miles and *Ophyra leucostoma*, 7 miles.

It is believed that the following of vehicles by flies in these experiments was unimportant. In general the experiments suggested that there is a natural tendency toward dispersion exhibited by both sexes of all species used in the tests. Many apparently favorable feeding and breeding places were passed in the course of migration. The relationship between direction of travel and the direction of the wind appeared not to be very close.

The many practical bearings of the question of distance and rapidity of travel of flies cannot be discussed here, but are apparent to all.

It might be pointed out that this is the first series of experiments in which flight studies have been made with flies other than *Musca domestica*.

NOTES ON PHLEBOTOMUS SPECIES ATTACKING MAN[1]

By D. C. Parman, *Bureau of Entomology, United States Department of Agriculture*

Observations have been made on Phlebotomus sp.[2] attacking human beings at Uvalde, Texas, during the months of September, October and November since 1915. The writer has been located at Uvalde since October, 1913, but the species was not observed until the fall of 1915. It is quite possible that the insect was present before that season and may be native in the region, but the people generally spoke of it as "the new musquito or bug that bites so hard." Considerable complaint was received during the fall of 1915 from residents of the higher parts of the town. My first experience with the bite was during the latter part of October. I was at a table under an electric light and was bitten on the face by what was evidently a Phlebotomus. Specimens were taken later and so identified.

Heretofore no records of the occurrence of Phlebotomus in the Southwest have been made and there are no published statements regarding the attack upon man by *Phlebotomus vexator* Coq., the only species of this genus known to occur in the United States. The occurrence of

[1] Published with the permission of the chief of the Bureau of Entomology.

[2] A determination of the species concerned has not been secured.

Phlebotomus in the Southwest and the fact that they appear to attack man freely deserves some attention, owing to the fact that this group of insects is known to carry papataci or three-day fever in the Mediterranean region, and evidence also points to its acting as vector of verruga in the Peruvian Andes.

During the fall of 1916 the infestation was heavier than the previous season and the appearance was about a month earlier; in 1917 the infestation was lighter but was present at about the same dates, the latter part of August until November. The early heavy freezes during the fall of this year caused an earlier disappearance. In 1918 the insect appeared the first part of September and disappeared in the latter part of November. The earliest authentic record of appearance is September 3, 1916; the latest record is November 24, 1915. During 1916, 1917 and 1918, the species was present in greatest numbers from September 25 to October 10. The adults always disappear with the occurrence of freezing weather. The abundance is extremely variable and amounts to from only one specimen attacking in several nights, to as many as twenty-five or thirty attacking each night for a short period during the height of the infestation. Rarely more than four specimens have been observed on a person at one time, and the greatest number was seven.

The bite is very painful and the sensation will last as long as one minute or more. There is no warning of the approach or attack and one is not aware of the presence of the insects until they are well seated. They are not easily disturbed after they begin to feed and are generally easily captured. I have allowed them to feed from ten to sixty seconds on my arm and none have ever appeared to complete a meal. The after effects of the bite last from twelve hours to as long as two or three days. On some persons there is no swelling, but a slight reddening of the area surrounding the point of attack; on others the swelling is considerable, the raised place being about two inches in diameter and nearly one-fourth inch high and is always attended by itching which continues for some time after the swelling leaves.

The insect is quite active at night but not nearly so evasive as the mosquito, the flight being more deliberate. When disturbed during the day flight is sluggish and irrational. The insects are found hiding in dark places during the day only, one or two specimens at a place. They have never been observed to venture out of hiding until well after sundown and the attack has never been observed earlier than eight o'clock or about one hour after sundown. They have been observed to be most numerous at lights on dark nights, but have been known to attack in late twilight but not in the dark or moonlight.

No data as to the breeding habits have been collected, but there is

some evidence that the breeding places are in neglected poultry houses. They have been observed to be quite abundant around such places during the late twilight hours. Observations have been made to note if they attack poultry, but all have been negative.

Aside from the annoyance of the bite of the Phlebotomus it is quite probable that it is a carrier of disease. There is some evidence of a circumstantial nature that is incriminating. During the fall of 1916 there was an outbreak of a mild form of what was termed by the local physicians dengue fever, the latter part of September and in early October. The outbreak was practically an epidemic. The disease occurred in 1917 with a smaller number of cases. In 1918 there were many cases of Spanish influenza and the local physicians are uncertain as to whether any cases of the so-called dengue appeared. The fever lasts about three days and runs about 102°F. to 103°F. There appears to be a tendency toward a recurrence of the fever each year in some cases.

GRASSHOPPER CONTROL IN KANSAS[1]

By George A. Dean, *Entomologist, Kansas State Experiment Station,* E. G. Kelly, *Extension Entomologist, Kansas State Agricultural College,* A. L. Ford, *Special Agent, U. S. Bureau of Entomology*

During the summer and fall of 1918, the grasshopper outbreak in Kansas was one of the worst in the history of the state. The outbreak did not come without warning, for in the previous year, in several localities in western Kansas, the grasshoppers were present in such damaging numbers that control measures had to be practiced in order to save the crops. It was evident that should the eggs be deposited in large numbers, and should the weather prove favorable for most of the egg capsules to pass the winter uninjured, the season of 1918 would be one of the most serious grasshopper years that the state had experienced. In the fall, the Department of Entomology and Extension Division of the Kansas State Agricultural College, in coöperation with the Federal Bureau of Entomology, placed an agent[2] in

[1] Contribution from the Entomological Laboratory of the Kansas State Agricultural College, No. 37.

[2] Mr. Scott Johnson, special field agent of the Federal Bureau of Entomology, did the survey work in the fall of 1917, and assisted with the extension work during the winter and early spring of 1918, at which time he entered the navy. Because of the urgent need of continuing the work, Mr. A. L. Ford, scientific assistant, Bureau of Entomology, on request, was transferred from the investigational work to the extension service. Much of the success in organizing the farmers to poison the grasshoppers and to disk to destroy the eggs was due to Mr. Ford's excellent work in the field.

western Kansas to make a grasshopper egg survey. Throughout the western part of the state the eggs were found in large numbers. In the spring following the dry cold winter, another survey was made and it was found that a high percentage of the eggs had come through the winter unharmed, and thus it was almost certain that in order to protect the crops a campaign on grasshopper control would have to be conducted.

It was decided to conduct the campaign by holding demonstration meetings, personal farm visits with demonstrations, and by appropriate window displays throughout the counties where prospects for grasshopper outbreaks were favorable. This work was started in the field on May 13, which was about the normal hatching time of *Melanoplus differentialis* and *M. bivittatus*. During the next seven weeks, 21 counties were covered, in which 24 demonstrations were given, 16 window displays arranged, and 240 farmers visited on their farms and given instructions. At each demonstration the life-history of the grasshopper was explained and a small amount of poison bran mash was properly mixed and distributed with a sowing device.[1] In this way the farmers could actually see the process and should make no mistake in mixing large batches for use on their farms. Not only was much interest shown at these demonstrations, but the proposition actually was put into practice by a great number of farmers.

In three counties, Finney, Hamilton, and Kearney, the ingredients for the poison bran mash were provided for out of county funds, and was distributed in the fields following the first cutting of alfalfa. In practically every instance where the poison was used the second crop of alfalfa came on normally. However, many farmers did not use the poison, and almost without exception they cut but one short crop of

[1] Device described by T. H. Parks, Journ. of Econ. Ent., Vol. 10, No. 6, pp. 524–525, 1917.

EXPLANATION OF PLATE 10

1. Demonstration meeting at Olmitz, Kans., attendance 127. The wheat to the left of the road completely destroyed from 15–20 rods back from the road. Egg pods very numerous along the roadside.

2. Demonstration meeting at Offerle, Kans., attendance 70. Wheat to the right of the road destroyed. The grass land between the wagon road and the railroad contained a large number of egg pods.

3. Demonstration meeting on a Ford county farm, attendance 10. Picture shows an uncultivated strip of land with wheat on either side. A typical place for oviposition. Egg pods were very abundant.

4. Demonstration meeting at Heizer, Kan., attendance 23. A hard beaten fence-row between two wheat fields. A typical place for oviposition. Egg pods were very numerous. Both wheat fields badly injured.

All photographed by A. L. Ford.

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alfalfa during the entire season. In several other counties the farmers purchased their own poison, and saved their alfalfa.

During the latter part of June, a large amount of poison bran mash was used in the sugar beet district of the state, and excellent results were had in protecting the sugar beets. Later in the summer the farmers of Thomas County organized, distributed the poison bran mash, which was provided by the county, and protected their alfalfa, and forage crops.

Throughout the earlier part of the summer a close watch was kept on the hopper situation. In western Kansas the small egg capsules of the late hatching *Melanoplus atlanis* were present everywhere in the hard soil in large numbers, and it was then evident that the farmers would have trouble with this pest on their wheat in the fall. Early in September reports began to come to the effect that the small lesser-migratory hopper was doing serious damage to the early fall planted wheat throughout the western part of the state, and thus a second campaign for demonstrations on grasshopper poisoning was arranged. A survey of the situation not only revealed the grasshopper present in dangerous numbers, but also that large numbers of eggs were already deposited in the soil in places accessible to the disk. Since the time for poisoning *M. atlanis* was in the early fall, and since this was also the proper time to emphasize the importance of destroying eggs, it was decided to combine both poisoning and fall disking to destroy the eggs in these demonstrations. This campaign proved to be a complete success. The attendance at the demonstrations was large, and unusual interest was shown by the farmers, especially in the fall disking demonstrations.

In this campaign in western Kansas, 12 counties were covered in which 59 demonstrations were given with a total attendance of 1,273 farmers, or an average of 22 at each demonstration.[1] At these meetings a short explanation was given of the life-history of the grasshopper, with special emphasis on the oviposition habits. The proper method of mixing and applying the poison bran mash was explained and demonstrated. Following the discussions on poisoning, the fall disking proposition was taken up in the following manner: The crowd was conducted to a nearby roadside or fence row where grasshopper eggs were abundant. Grasshopper oviposition was reëxplained, with special emphasis on the place of oviposition. (There nearly always is found a very large number of eggs in the hard grassy places at the edge of cultivated fields. The reason for this is that in the fall the majority

[1] Had it not been for the state ban on all public meetings on account of the influenza epidemic, much more could have been accomplished. Practically all the scheduled demonstrations after October 16 were cancelled.

of hoppers are found feeding on the most succulent food which is usually in cultivated land. Since they do not oviposit in loose cultivated soil, they migrate to hard ground and they usually stop at the first favorable place, and thus the egg capsules are very numerous along the edge of the cultivated fields.) The egg capsules were dug up and passed around, the number of eggs in several pods were counted and the number of pods to each spadeful of earth was determined. In this way it was impressed on the farmers just how many eggs an uncultivated roadside or fence row could harbor. It was interesting to notice that although these farmers had been fighting grasshoppers for years, very few of them had ever seen or noticed one of the egg pods before.

After the farmers were convinced of the places of grasshopper oviposition, and of the overwhelming abundance of the eggs, a piece of roadside or fence-row was then actually disked, and they were shown just how the egg capsules were torn up and exposed by this process. In every case it was no trouble to find eggs torn from the pods and scattered broadcast behind the disk, and in every case the farmers were fully convinced that fall disking of the hard grass places adjacent to cultivated fields was a very important factor in solving the grasshopper problem in Kansas.

At each meeting coöperation was emphasized as much as possible and in many cases whole townships actually organized at the meetings to do the disking later as a unit. A grasshopper-egg disking day was set aside, at which time all farmers in a community arranged to disk their fence-rows, irrigation ditch banks and roadsides.

In checking up the results of the various campaigns against grasshoppers in Kansas in 1918, we find that eight counties, Thomas, Sheridan, Ford, Finney, Kearney, Hamilton, Meade, and Seward, furnished white arsenic to their farmers and, with the exception of Finney County, the rest of the ingredients for making the poison bran mash.[1] In these eight counties, 35,500 pounds of white arsenic, 355 tons of bran and sufficient syrup and lemons to go with this amount of arsenic and bran were put out as county projects. Even this large amount was not sufficient to go around and many of the farmers in these counties bought their own materials.

Questionnaires were sent out to a large number of local druggists throughout the western part of the state to determine the general run of white arsenic and Paris green sales as compared with previous years. It was found that this representative group of local druggists sold

[1] Two other counties organized for the purpose of furnishing materials to their farmers, but found the supply of arsenic exhausted.

more than twice as much white arsenic and Paris green than they did the previous year.

The results of the grasshopper poisoning were excellent throughout the state. Very few reports of poor results were received, and in practically every case these were due to improper methods in mixing and applying. Very few cases of poultry or stock poisoning were reported, and without exception all such cases were due to carelessness on the part of the farmer. In every county where poisoning was done extensively, the farmers were more than pleased with their results. Thousands of acres of alfalfa, wheat and other crops were actually saved from the ravages of the grasshoppers.

As a result of the fall disking demonstration, seven counties organized to disk fence-rows, roadsides, and other hard grassy places adjacent to cultivated land.

A USE OF GALLS BY THE CHIPPEWA INDIANS

By William A. Riley, *University of Minnesota*

In a recent paper,[1] Margaret M. Fagan has presented a valuable summary of an extensive study of the literature dealing with the uses of insect galls. In the course of her discussion she says, "So far as can be ascertained no American galls were ever used for any practical purposes by the Indian (statement of Dr. Hough, United States National Museum), and but few by the white man."

In view of this statement is it worthy of record that a gall on the sumach, *Rhus glabra*, is used medicinally by the Chippewa Indians in Minnesota.

This gall is produced by an undetermined mite, referred to in the literature as a species of *Eriophyes*. It has been well figured by Thompson, 1915 (pl. 19, fig. 97), as "*Eriophyes*, or fungus on *Rhus copallina*," and by Felt, 1918 (text-fig. 164, and pl. 16, fig. 7). It occurs very commonly on *Rhus glabra* in Minnesota, causing characteristically stunted heads and curled leaves. These deformed heads are collected by the medicine men in late summer, and used in the form of an infusion as a remedy for diarrhœa. I am told that they are also used in the preparation of a poultice for the treatment of burns, but could learn no further details.

It is well known that owing to the quantity of tannin which they contain, galls are powerfully astringent. The earlier editions of the

[1] American Naturalist, 1918, LII, 155–176.

United States Dispensatory spoke of them as occasionally employed in cases of chronic diarrhœa. The last (20th, 1918) edition contains the somewhat contradictory statement that they "are no longer prescribed internally. Aromatic syrup of galls is sometimes prescribed." This syrup is a form in which they were employed in the treatment of diarrhœa.

Officinal galls are derived almost exclusively from *Quercus infectoria*, and this is recognized as their source in the United States Pharmacopœia. They are produced by *Cynips gallætinctoriæ* Olivier, and are of the well-known hard, spherical type, about ten to twenty millimeters in diameter. They are often known in commerce as the Aleppo galls, since they formerly were largely produced in the vicinity of the Syrian city of that name.

The most significant feature of the use of galls by the Indians for the same disease as that for which the officinal preparations were more often used, is that the Indians use a type of gall differing radically from that above described. Doubtless both owe their efficacy to the presence of tannin but it is clear that the Indian usage could not be a modern one, derived from that by the whites.

Scientific Notes

Hessian Fly: Supplementing previous outdoor experiments, to determine whether or not certain strains of wheat are actually less severely attacked by the Hessian fly than others, the Department of Entomology of the Missouri Agricultural Experiment Station is carrying through an interesting series of greenhouse experiments. Some difficulty has been experienced in making growing conditions absolutely uniform, where a large series of varieties are tested and the conditions under glass are naturally not exactly the same as in the field. Standard Missouri varieties as well as others previously reported as having resistant qualities are being used in the experiments. The pest seems to breed and develop normally indoors on all strains tested, but in the first test just completed, some varieties are decidedly less severely attacked than others. Chemical tests and observations on different structural variations of the indoor plants are also being made the same as in case of the field experiments.

Leonard Haseman.

European Corn Borer In Connecticut: What appears to be a small infestation of the European Corn Borer, *Pyrausta nubilalis* Hubner, was found in Milford, Conn., March 12, by assistant entomologists from the Agricultural Experiment Station. The infestation lies just north of the village, and at this writing its limits have not been definitely ascertained. Prompt measures will be taken to suppress the pest.

W. E. Britton.

A Correction: In the Journal of Economic Entomology, Vol. 11, No. 5, p. 431, I made the statement that I had found the Cherry-Leaf-Beetle, *Galerucella cavicollis* LeC., feeding on several species of azalea. This azalea feeding beetle, I now find, on more carefully comparing the specimens, is *Galerucella rufosanguinea* Say. To my good friend, Dr. E. A. Schwarz, I am indebted for calling my attention to the matter.

Berkeley, Cal., March 3, 1919. Edwin C. Van Dyke.

A New Root Maggot Treatment. The soils and climatic conditions of the Pacific Coast are such that most cruciferous crops thrive exceptionally well. Cabbage, cauliflower, turnips, radishes and the like are grown in most every garden and are standard market garden crops; thousand-headed kale is grown by almost every dairyman and poultryman; and the cabbage seed-growing industry of the United States is centered largely in Skagit County of the State of Washington. These crops are therefore very important in the agriculture of western Washington. All of these crops are infested more or less each year by the cabbage root maggot (*Phorbia brassicae* Bouche). The damage done by this pest makes it one of the most important insect pests which we have to combat.

Each season for many years past experiments looking toward the control of this pest have been carried on at the Western Washington Experiment Station. New treatments tried from year to year have so added to the "found wanting" list that it makes quite an impressive array of blighted hopes. Of the many treatments that have been tried, the tarred felt collar for transplanted crops such as cabbage, kale and cauliflower has been the most effective prior to this season.

The use of powdered borax to kill house-fly maggots in manure as recommended by the United States Department of Agriculture and the successful use of "green tar oil" in English army camps to prevent manure heaps from becoming a breeding place for house-flies suggested to the writer their use for root-maggot control. Accordingly, this past season these two materials were tried along with the usual number of new "remedies."

The recommended borax treatment to kill house-fly maggots in manure is 1 pound of powdered borax to 16 cubic feet of manure. Based on this recommendation ½ pint of a solution in which 1 ounce of powdered borax is dissolved in 10 gallons of water should effectively treat 10 cubic inches of soil. This was assumed to be about the proper treatment for one plant. Solutions of 1 ounce of powdered borax to 2½ gallons, 5 gallons, 10 gallons and 15 gallons of water were used at the rate of ½ pint to the plant. The stronge concentrations had a slightly injurious effect on the kale plants, thousand-headed kale being used in these experiments. Some few plants were killed and others were noticeably stunted. These treatments showed practically the same percentage of loss as the checks, so are apparently of no value in the control of root maggot.

"Green tar oil" used at the rate of 1 part to 40 parts of soil, applied 1 inch thick on manure heaps, has been reported (W. H. Saunders in the 1916 *Proceedings of the London Zoölogical Society*) to effectively protect them from becoming a breeding place for house-flies. This oil is a heavy coal tar distillation product known in this country as anthracite or anthracene oil. It is insoluble in water and non-volatile. It was obtained from The Barret Company, New York, and The Republic Creosoting Company, Seattle. The latter company reports that anthracene oil will retail at approximately $1 a gallon.

In our experiment with anthracene oil, soil from the field in which the transplanting was to be made was used as a carrier rather than anything else, because in that way

nothing other than the oil was introduced and because the mixture was easily made, simple and inexpensive. The anthracene-oil-treated soil was scattered around the base of the plant to form a protecting collar, 1 gallon of the mixture being used to about 200 plants. The rates used were 1 part of the oil to 20, 40 and 80 parts of soil by measure. It was hoped to establish the upper and lower limits of concentration that were effective and non-injurious. The 1 to 20 mixture proved injurious to the plants, as a number died as a result of the treatment. The results indicate that the 1 to 80 mixture may be stronger than necessary, as this treatment proved most effective. Distillate was used in one test to thin the oil to facilitate mixing. The treatments were applied as soon as the kale was transplanted. The results secured with these treatments follow:

Kale Transplanted July 6–10

Treatment	Number of Plants Treated	Final Count of Missing Plants	Per Cent of Loss
Untreated	185	86	46.5
Anthracene, 1–20	70	14[1]	20
Anthracene, 1–40	80	10	12.5
Untreated	35	17	48.6
Anthracene, 1–80	125	13	10.4
Anthracene, 1–40 (Oil diluted with distillate)	61	12	19.8
Untreated	185	59	31.9
3 Untreated	305	162	40
4 Anthracene Treatments	336	49	14.6
Tarred Felt Collars	184	27	14.7

As only a small amount of anthracene oil is necessary in the mixture and soil is a satisfactory carrier, this treatment is cheap, readily prepared and easily applied. If it proves as effective in succeeding seasons as it did in our experimental plots this year it should come into general use

E. B. Stookey.

MEETING OF PACIFIC SLOPE BRANCH AMERICAN ASSOCIATION OF ECONOMIC ENTOMOLOGISTS

The annual meeting of the Pacific Slope Branch will be held in connection with the State Fruit Growers' Convention, at the Citrus Experiment Station, Riverside, Cal., May 28 and 29.

This meeting has been set especially to accommodate the visiting Eastern and middle West entomologists, many of whom are to attend this convention. Regular announcements have been sent to all members living west of the Rocky Mountains. Earlier decisions to hold this meeting at Berkeley or Pasadena have been changed in favor of Riverside as stated above.

A cordial welcome is extended to all visiting entomologists. They will find the Citrus Experiment Station and the School of Subtropical Agriculture most interesting and inspiring. The meetings and discussions can not fail to interest entomologists.

E. O. Essig, *Secretary.*

H. J. Quayle, *Chairman.*

[1] Part of loss due to the effect of the treatment.

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OFFICIAL ORGAN AMERICAN ASSOCIATION OF ECONOMIC ENTOMOLOGISTS

APRIL, 1919

The editors will thankfully receive news items and other matter likely to be of interest to subscribers. Papers will be published, so far as possible, in the order of reception. All extended contributions, at least, should be in the hands of the editor the first of the month preceding publication. Contributors are requested to supply electrotypes for the larger illustrations so far as possible. Photo-engravings may be obtained by authors at cost. The receipt of all papers will be acknowledged.—Eds.

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Our most important farm crop is threatened with very serious injury by a recently introduced insect. This pest has a bad record in Europe. It has demonstrated in this country its ability to cause very great losses when allowed to multiply unrestrictedly and its known distribution indicates an ability to maintain itself throughout our corn belt. Furthermore, studies conducted during the last two seasons in the infested area in Massachusetts have resulted in finding no really satisfactory method of control. This recent introduction appears to have become established in only a few relatively limited areas.

The European corn borer is unquestionably a serious menace to our enormous corn areas and to some related crops, particularly Kafir corn. Its natural spread appears to be slow, though evidence at hand indicates at least two and possibly more commercial jumps, which mean the establishment of the pest in centers remote from other infested areas and in some sections at least where natural agents of dissemination, such as flood waters, may prove a most important factor in carrying the insect into new territory. The situation is further complicated by the occurrence of the pest in badly infested areas in the stems or stalks of a variety of garden vegetables, a number of grasses and common weeds, the latter greatly increasing the difficulty of control or extermination.

The situation is a critical one. The insect is injurious, not easily controlled and the feasibility of extermination has yet to be demonstrated. Nevertheless, the spread of the insect through both natural and artificial agencies is continuing and very soon its dissemination

may be so general as to make eradication or extermination impractical. This is a problem which has been thrust upon American entomologists by conditions over which they have no control. It must be solved within a few months. The value of the crop threatened is so great and the interests affected so vital to our national welfare, that we feel that nothing short of a most energetic effort to meet the situation and avert, if physically possible, the probability of subsequent enormous annual losses can be justified in the future.

Review

Key to American Insect Galls, by Ephraim Porter Felt, D. Sc. Bulletin 200 New York Museum, 310 pages, 16 plates, 250 figures, Albany, N. Y., 1918.

Though several bulletins and many scattered papers have been published on American insect galls, none have the object or scope of Dr. Felt's work which brings together in one volume a tremendous amount of information in a form most convenient for the busy worker to use in identifying galls. In plan, the hosts are arranged according to the botanical relationship of the families, and under each family or genus is a workable key or table for separating the galls occurring on the plants of that division. A large proportion of the galls are illustrated by excellent line drawings or by photographs reproduced in half-tone on the plates. The descriptions, though brief, are sufficient, together with the illustrations for purposes of identification. The insects forming galls on each family or group of plants are given in tabular form near the end of the book. An excellent index combining both plant and insect names renders the volume convenient for ready reference. Though Dr. Felt has for many years been studying dipterous galls and has described many new species and published a number of papers, probably none of his work will be appreciated by entomologists and laymen as much as this successful attempt to bring together in one volume, all American gall insects and their hosts, with means of ready identification. (*Adv't.*)

W. E. B.

Current Notes

Conducted by the Associate Editor

Mr. Hugh Knight has been appointed assistant in entomology at the citrus substation at Riverside, Cal.

Miss Evelyn Osborn has accepted the position of assistant entomologist with the Florida Experiment Station.

Mr. C. C. Hamilton has been appointed extension instructor in entomology at Missouri University and Station.

Mr. A. T. Speare of the Bureau of Entomology recently received the degree of doctor of philosophy from Harvard University.

Mr. H. J. Reinhard has been promoted from assistant entomologist to entomologist, of the Texas Agricultural Experiment Station.

Mr. A. C. Baker of the Bureau of Entomology recently received the degree of doctor of philosophy from George Washington University.

Mr. C. A. Weigel, connected with the Federal Horticultural Board, has recently been released from military service and resumed his duties in Washington.

Seven field men were scouting Eastern Pennsylvania during March for the European corn borer, under the direction of Prof. J. G. Sanders, economic zoölogist.

Mr. E. H. Siegler of the Bureau of Entomology gave an illustrated address before the Connecticut Pomological Society at Hartford, Conn., on January 24, 1919.

Mr. G. N. Wolcott, who has been in the service with the A. E. F. in France, has returned to Cornell University where he has begun work for his doctor's degree.

Lieut. F. H. Lathrop, assistant entomologist in the Oregon Experiment Station was released from military service early in the year and has returned to his duties in Oregon.

Captain R. D. Whitmarsh of the U. S. Army, formerly assistant entomologist of the Ohio Agricultural Experiment Station, has been assigned to duty at Houston, Texas.

Mr. J. M. Robinson, formerly in extension service in Tennessee, has entered upon work in the Department of Entomology in the Alabama Polytechnic Institution, Auburn, Ala.

Mr. J. B. Garrett, entomologist of Agricultural Experiment Station, Baton Rouge, La., is on an indefinite leave of absence, and the work is in charge of W. E. Anderson, acting entomologist.

Mr. Charles P. Alexander of Kansas State University has been appointed systematic entomologist and custodian of collections for the Illinois State Natural History Survey, Urbana, Ill.

Mr. M. L. Benn, field assistant on crop pests with the Bureau of Zoölogy of Pennsylvania, is taking special work at Cornell University this year, in entomology, plant pathology and horticulture.

Mr. Geo. G. Becker has been released from the Navy and has accepted a temporary appointment with the Bureau of Entomology to do extension work on deciduous fruit insects in the state of Arkansas.

Mr. W. E. Jackson has returned as assistant entomologist and chief apiary Inspector of the Texas Agricultural Experiment Station, after a year of service in the medical laboratory of the U. S. Army.

Mr. I. L. Ressler, recently discharged from the Chemical Warfare Service, has taken up his former work as instructor in the Zoölogy and Entomology Department of the Iowa Agricultural College at Ames.

Dr. J. McDunnough has relinquished his position as curator of the Barnes collection, Decatur, Ill., to accept a position, April 1, in the Entomological Branch of the Department of Agriculture at Ottawa, Ont., Canada.

Mr. J. V. Ormond, of the Bureau of Entomology and C. C. Hamilton, extension entomologist of the Missouri College of Agriculture are just completing two months of successful work in organizing the beekeepers of Missouri.

Lieut. W. H. Larrimer of the Bureau of Entomology has returned from army service and resumed work at LaFayette, Ind., where he will be in charge of the field laboratory in place of Mr. J. J. Davis, who has been transferred to New Jersey.

Dr. H. M. Parshley has been promoted to an associate professorship in the Department of Zoölogy at Smith College, Northampton, Mass. He has also been appointed associate in field zoölogy at the Cold Spring Harbor summer laboratory.

Mr. Paul A. Mader, who was engaged in white pine blister rust scouting in Pennsylvania, and volunteered for service, and was stationed at Newport News in Sanitary Corps work, has returned to the Bureau of Economic Zoölogy at Harrisburg.

Mr. Kenyon F. Chamberlain has been appointed assistant in entomology at the Connecticut Agricultural Experiment Station, New Haven, Conn. Mr. Chamberlain was employed temporarily by the station during the summer and early fall of 1918.

Sergeant H. M. Fort has been discharged from military service where he was in charge of the Laboratory at the Base Hospital at Camp Gordon, Ga., and will take up special bacteriological investigations in entomology at the University of Missouri.

Prof. H. A. Gossard of the Ohio Station addressed the Paper Shell Pecan Growers' Association at Chicago, March 8. One other address was given the same evening by Mr. C. A. Reed of Washington, nut culturist of the United States Department of Agriculture.

Messrs. J. E. Graf and C. H. Popenoe, of the U. S. Bureau of Entomology, and at present engaged in eradicating the Sweet Potato Root Weevil in Baker County, Fla., were present at the meeting of the Florida Entomological Society held on the evening of March 3, 1919.

Mr. J. L. King, after seven months' service in the U. S. Army, has returned to the Pennsylvania Bureau of Zoölogy, Harrisburg, and will be engaged in fruit insect pest investigations at Chambersburg, Pa., where the bureau will maintain a field laboratory during the growing season.

Dr. Leonard Haseman and Instructor K. C. Sullivan, of the Department of Entomology of the Missouri University, are completing plans for taking a class of research students into the swamp sections of the state during the spring term, to study mosquito and malarial problems.

Mr. Albert Hartzell has been discharged from the army service where he was a corporal in the Infantry, and has resumed his position as instructor in the Department of Zoölogy and Entomology of the Iowa State College. Mr. Hartzell's name was omitted from the Roll of Honor.

Mr. W. H. Goodwin, formerly of the Ohio Agricultural Experiment Station, visited the Station, March 7. Mr. Goodwin has been employed in extermination work directed against the Japanese beetle at Riverton, N. J., but recently has been transferred to extension work in that state.

Prof. Lawrence Bruner, head of the Department of Entomology, University of Nebraska, is now on leave of absence in California in an effort to regain his health. He is now considerably improved. During his absence, departmental activities are in charge of Professor Myron H. Swenk.

Messrs. R. H. Hutchinson, E. R. Sasscer and E. A. Back of the Bureau of Entomology have been designated as a committee to act in coöperation with a committee from the Bureau of Chemistry to investigate the possible utilization of poisonous gases used in warfare for fumigation against insects.

Dr. F. A. Fenton, formerly of the Bureau of Entomology and later fellow in zoölogy and entomology, Ohio State University, who has been recently released from military service, has accepted an appointment as research assistant in the Iowa Experiment Station and entered upon his duties there in March.

Mr. D. M. DeLong has returned to the Bureau of Economic Zoölogy, Harrisburg, Pa., after serving seven months in the Sanitary Corps at the Yale Army Laboratory School and at Camp Devens, Mass. He will be located during the summer months at the field laboratory of the above bureau at North East, Pa.

Capt. Herbert T. Osborn, who has been in military service since July, 1917, received his discharge in December and has been visiting the Osborn family in Columbus, Ohio, but will return to his position in the Entomological Division of the Hawaiian Sugar Planters' Association Experiment Station in Honolulu early in April.

Appointments in the Bureau of Entomology are announced as follows: R. V. Rhine, apicultural extension work in Kansas; Edward R. Jones, for work on tobacco insects; Richard T. Cotton, to study *Calandra* attacking corn; J. C. Furman, stored product insect investigations; R. F. Wixson, apicultural extension work, Virginia.

Mr. John J. Davis, in charge of the field laboratory of the U. S. Bureau of Entomology at West Lafayette, Ind., has been transferred to New Jersey, beginning May 1, where he will take up the work of eradicating the Japanese Beetle, *Popillia japonica* Newm, in coöperation with Dr. T. J. Headlee, state entomologist of New Jersey.

The following members of the Bureau of Entomology, and who entered military service, have been honorably discharged from the service and have been reinstated in the bureau: W. D. Whitcomb, C. H. Alden, R. W. Kelley, E. W. Scott, Dr. G. F. White, Capt. E. H. Gibson, A. C. Mason, Max Reeher, J. U. Gilmore, T. P. Cassidy.

The Entomological Department of Purdue University, LaFayette, Ind., will put on a short course in apiculture, of one week's duration, beginning April 7, 1919. Dr. E. F. Phillips of the U. S. Bureau of Entomology, and other noted apiculturists will take part in the discussions. The course is intended principally for commercial bee-men.

Mr. J. S. Houser made a trip through northeastern Ohio, March 13 to 15, to locate some orchards suitable for spraying experiments and to do some preliminary scouting for possible discovery of the European Corn Borer. Mr. Houser was called to Columbiana County as an expert witness in a case regarding a carload of wheat infested with insects.

According to the *Experiment Station Record*, at the New Jersey Station, the experimental cranberry investigations, including tests of fertilizers, drainage, and insect control have been summarized, and with these data as a basis a new project on various phases of cranberry culture has been begun in charge of C. S. Beckwith, assistant entomologist.

According to *Science*, "it is announced that *Genera Insectorum*, the great work describing all the genera of insects, published at Brussels, is to be continued. When the country was invaded in 1914, several parts were about to be published; these are to appear in 1919. The stock of the previously published parts was saved, and is now available."

A memorial service was held December 8, 1918, at the University of Chicago, for the late Prof. Samuel W. Williston, formerly professor of paleontology. The speakers were Prof. E. C. Case, University of Michigan, Prof. Stuart Weller of the Department

of Geology and Paleontology, and Prof. Frank R. Lillie, Department of Zoölogy, University of Chicago

Mr. J. R. Stear, formerly of the Ohio Agricultural Experiment Station, visited the Station, March 7. Mr. Stear has been mustered out of the military service and is spending some time with his parents at New Brighton, Pa. He is waiting to see if Ohio can give him fair treatment in way of salary before deciding whether he will resume work at the station.

A school for bee-keepers was held at Cornell University during the week of February 24 to March 1, under the direction of the Department of Entomology in coöperation with Dr. E. F. Phillips and George S. Demuth of the Bureau of Entomology at Washington, D. C. The attendance and interest were very gratifying. The total registration for the week was 145.

Mr. W. O. Hollister of the Bureau of Entomology, stationed at the field laboratory at West Lafayette, Ind., has resigned to return to the Davey Institute of Tree Surgery at Kent, Ohio, as entomologist of the Research Bureau. Mr. Hollister was connected with the Davey Institute for several years and joined the forces of the Bureau of Entomology during the war.

Mr. M. D. Leonard, who was formerly entomologist of the Erie Co. Laboratory of the Pennsylvania State College, has been appointed special field agent of the U. S. Bureau of Entomology. He will be stationed on Long Island to carry on extension work in the control of truck-crop insects in coöperation with the Department of Entomology at Cornell University.

Mr. H. H. Knight, formerly investigator in entomology to the Cornell University Experiment Station and who has been in command of a corps of men in the Photographic Section of the Aviation Service in France has returned to this country. He expects to receive his discharge in a few weeks and will then resume his investigations on the biology of the Miridæ (Capsidæ).

Prof. G. M. Bentley, state entomologist and pathologist of Tennessee, is secretary-treasurer of the Tennessee State Florists' Association, the Tennessee State Horticultural Society, the Tennessee State Nurserymen's Association, and the Tennessee Beekeepers' Association. These organizations all held their annual convention at Nashville, Tenn., Jaunary 28–31, 1919.

A Senate Bill appropriating fifty thousand dollars ($50,000), with $10,000 immediately available, for European potato wart disease control, has been introduced in the Pennsylvania Legislature. The economic zoölogist has quarantined four townships about Hazleton, Pa., with an area of approximately 120 square miles, and three local points outside this main infected area.

Dr. J. H. Montgomery, quarantine inspector, Florida State Plant Board, has gone to New Orleans, La., to confer with Messrs. Compere (California) and E. R. Sasscer (Federal Horticultral Board) on account of the Black Fly (*Aleurocanthus woglumi*) situation. This aleurodid is not known to be present in the United States, but occurs as a severe pest of citrus and other fruit trees in the Bahamas, Cuba and Jamaica.

The Florida State Plant Board has arranged to furnish the farmers in Baker County with about one million weevil-free sweet potato draws, under condition that they bed none of their own potatoes, which are generally infested with the Sweet Potato Root Weevil (*Cylas formicarius*). This arrangement is part of the plan for exterminating the weevil from the infested part of this county. The plants are being grown by the Plant Board.

Prof. J. M. Swaine of the Canadian Entomological Branch and known for his splendid work on the Scolytid bark-beetles is at Cornell University completing his work for the doctor's degree. He expects to take his examination some time during the latter part of March. His thesis on the Canadian bark-beetles has already been published as Technical Bulletin No. 14, Parts I and II, by the Canadian Department of Agriculture, Entomological Branch, Ottawa, Canada.

The following Florida entomologists served as speakers during the Better Fruit Campaign, recently (February 10 to 26) conducted in Florida under the auspices of the University of Florida Extension Division, with coöperation of the State Plant Board and the U. S. Department of Agriculture: Wilmon Newell, plant commissioner; W. W. Yothers, Bureau of Entomology, U. S. D. A.; J. R. Watson, Florida Experiment Station; E. W. Berger, State Plant Board; 3,090 people were addressed during the campaign.

The following transfers have been made in the Bureau of Entomology: E. R. Selkregg, deciduous fruit insect investigations, temporarily to Federal Horticultural Board; A. O. Larson, to extension fruit insect work in Utah; A. H. Beyer, Columbia, S. C., to Wichita, Kans.; A. L. Ford, Kansas to Knoxville, Tenn.; Max Kisliuk, Jr., to Wilmington, N. C.; A. D. Borden, to extension work in California; W. H. Goodwin, to extension work with fruit insects in New Jersey; Charles F. Moreland, from extension work to research on the sweet potato weevil.

Mr. A. C. Lewis, state entomologist of Georgia, announces that the Georgia State Board of Entomology has secured the services of Dr. D. C. Warren of Auburn, Ala., as assistant entomologist, with headquarters at Valdoats, Ga., to conduct dusting experiments for the control of the boll weevil. The State Board of Entomology conducted preliminary tests last year on this work. While the results secured were encouraging, they were not conclusive enough to make any recommendations in regard to dusting for the control of the boll weevil.

The electrical machine invented by F. S. Smith of Philadelphia for the control of insects in packages of cereals is now being installed in the factory of the Hecker Cereal Company of New York City. Tests made by Dr. Back and Mr. Smith, during November and December, showed a result of 100 per cent effectiveness in killing various cereal pests when these were introduced in "commercial numbers." The machine is of great promise and has awakened great interest among cereal concerns approached by its owners, M. E. Gillett and Son, of Tampa, Fla.

The following resignations from the Bureau of Entomology have been announced: E. L. Sechrist, bee culture to engage in commercial beekeeping in Haiti, where he will manage 2,000 colonies; H. G. Ingerson, grape insects, to accept a position at Ohio State University; J. F. Gardener, scientific assistant, cereal and forage crop insects, on account of ill health; R. H. Jung; John H. Moore, extension work; A. L. Johnson, inspector; J. U. Gilmore, southern field crop insect investigation; D. A. Ricker, cereal and forage crop insect investigations; A. B. Champlain, to accept a position with the economic zoölogist, Harrisburg, Pa.; W. O. Hollister, to return to Davey Institute, Kent, Ohio.

Mr. Alfred B. Champlain, Bureau of Entomology, who has recently been in charge of a field station for the study of forest and shade tree insects at Lyme, Conn., under Dr. A. D. Hopkins, has been appointed scientific assistant and curator of the state insect collections at Harrisburg, Pa., under Prof. J. G. Sanders, economic zoölogist. Mr. Champlain will have an opportunity for field work and biological and life-history investigations. He will retain his connections with the bureau as a collaborator.

Mr. Champlain started work in his new position March 1. He was formerly an assistant in the laboratory at Harrisburg, resigning some five or six years ago to accept a position in the bureau.

Prof. H. A. Gossard, Ohio Agricultural Experiment Station, attended a conference, March 4, of the entomological workers of the state at the office of the secretary of agriculture, to discuss ways and means of preventing the introduction of the European Corn Borer into Ohio, and of discovering its presence if it has already become established anywhere. A working coöperative program was arranged by which state-wide surveys will be made under the direction of the Bureau of Nursery and Crop Inspection, the entomologists of the Experiment Station and State University assisting. Secretary Shaw was to undertake securing from the Legislature, an emergency provision for handling any discovery of the insect that may be found.

The annual meeting of the entomological workers in Ohio institutions was held in the Botany and Zoölogy Building, Ohio State University, Columbus, Ohio, January 30, 1919, beginning at 9.30 A. M. The following papers were presented: Brief Addresses—Raymond C. Osburn, Head, Department of Zoölogy and Entomology, Ohio State University; H. A. Gossard, entomologist, Experiment Station; E. C. Cotton, chief, Bureau of Horticulture; H. A. Gossard—Timely Notes; Herbert Osborn—Further Notes on Meadow Insects; W. C. Kraatz—A Study of *Scirtes tibialis* Guer.; W. M. Barrows—Grassland Spiders, Stratification in Associations; Robert K. Fletcher—A Few Notes on the Miridæ of Meadows and Pastures; D. C. Mote—Report on Anthelmintic Experiments; T. H. Parks—The Bioclimatic Law (Law of Altitude, Latitude and Longitude) as Applied to Hessian-Fly Control in Ohio; Edna Mosher—Some Interesting Beetle Larvæ; A. J. Basinger—Preliminary Studies in Ohio Tachinidæ; C. H. Young—Notes on *Tropisternus glaber* (Herbst); R. C. Osburn—The Onion Fly, *Eumerus strigatus*, in Ohio; J. S. Hine—The University Entomological Collections; J. S. Houser—An Undeveloped Profession.

The sixth annual meeting of the New Jersey Mosquito Extermination Association was held at the Chalfonte Hotel, Atlantic City, N. J., February 6 and 7, 1919. About one hundred and fifty attended the first session on Thursday evening of February 6 and listened to a very interesting address, "Mosquito Control about Cantonments and Shipyards," by La Price of the U. S. Public Health Service. The Friday morning session was a symposium on "Mosquito Control." The work of the season was presented in ten-minute papers by members of the New Jersey County Commissioners from twelve counties. Nearly every county has one or more special mosquito problems and the important points in the solution of these problems were discussed, making this session of special interest to mosquito workers present from other states. At the afternoon session several papers were presented dealing with the emergency mosquito work around military camps, shipyards and munition factories. Among the interesting papers were "Mosquito Eradication in Southeastern Pennsylvania," by Dr. B. Franklin Royer, acting commissioner, Department of Health, of Pennsylvania; "Mosquito Control in Military Camps," by Russell W. Gies, and Jesse B. Leslie, captains in the Sanitary Corps of the U. S. Army. The last session of the meeting Friday evening was devoted to "The Problem of Finishing the Mosquito Drainage of the New Jersey Salt Marsh." An able paper was presented by Dr. Headlee, "The Work Involved, Its Approximate Cost and Maintenance." Other interesting papers were presented covering the attitude and the part of the various state and municipal organizations interested in the work. The New Jersey Mosquito Extermination Association is by far the leading organization devoted to mosquito control work in the country. The membership is over 2,200 and the annual meetings should be attended by every anti-mosquito worker in the country.

Mailed April 18, 1919

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EAR WORM INJURIES TO CORN AND RESULTING LOSSES

By Roger C. Smith, *Scientific Assistant, Bureau of Entomology, Charlottesville, Va.*

After reading practically all of five hundred and twenty-five references to the corn ear worm (*Chloridea obsoleta* Fab.) in literature, it has been observed that two serious sources of loss due to the activities of this well known pest have been overlooked. A brief discussion, therefore, of the various types of injury to corn caused by this insect, with observations from last year's study may prove of some practical value.[1]

It is well known that in most of the ear worm territory, the first generation of moths frequently oviposit on the unfolding leaves in the heart of the young corn plant. The larvæ upon hatching attack the tender leaves (Pl. 11, fig. 1) eating large and irregular holes in them. This injury has been variously designated in different localities as "rag worm" injury (Virginia), "shatter worm" (North Carolina), "heart worm" and "bud worm" injury (general). It would appear that there must be some injury to the vitality of the young corn plant though a few injured stalks under observation at this laboratory apparently overcame this injury and produced ears entirely comparable to stalks not thus injured and under the same growing conditions. Ear worm larvæ have several times been reported as boring into the stalk (Caudell, 1902),[2] but this habit is apparently unusual according to our observations.

The developing tassels are next attacked by the larvæ (Pl. 11, fig. 2). In this locality nearly grown larvæ are usually found doing this injury and in the few days' eating do considerable damage to the developing

[1] Acknowledgment is made to Mr. W. J. Phillips in charge of this laboratory for suggestions and criticism of this paper.

[2] Caudell, A. N. Notes on Colorado Insects. Bul. 38, N. S. Div. of Ent., U. S. Dept. of Ag., November 1902, p. 38.

staminate flowers. Were this feeding habit more frequent, a serious loss of pollen might result. A plat of two acres of field corn in which tassels were appearing July 3, 1918, was examined carefully and only ten tassels found to be thus injured. Since corn produces an excess of pollen, the loss of a few anthers is not serious.

By far the more important losses due to ear worm activity come from the attacks on the ears. It is well known that ear worm moths oviposit in the majority of cases on the fresh silks. The larvæ, upon hatching and after devouring the empty egg shells, begin at once to feed on the fresh silks. Sometimes the larvæ crawl down the silk strands well into the tip of the ear at once but not infrequently they feed more or less exposed on the silk at the tip for several instars (cf. Headlee, 1913).[1] Perhaps the most frequent type of silk injury is where the larva severs the strands some distance below the ends of the husks (Pl. 11, fig. 3). This condition is so frequent that a slight pull of the silk mass will generally indicate infested ears. If a part or all of the silk pulls out readily, ear worm work with but a few exceptions is assured. Where the silk does not yield, the husk must be opened to ascertain infestation.

Since it is through the silks or styles that the ovules are fertilized resulting in the development of the kernel, severance of the silk before fertilization will result in the absence of kernels on that part of the ear. It has been observed that the silks leading to the basal portion of the ear develop first and those to the tip, last. Dr. W. A. Taylor of the Bureau of Plant Industry, when asked for confirmation of this statement wrote (*in littera*), "the silks usually arise from a point an inch a two from the base of the ear. From this point the silking proceeds toward the tip and less rapidly towards the base. The last silks to emerge are from the tip of the ear." It appears that fertilization takes place over the greater part of the ear before ear worms reach the silks but some four or five days are necessary to fully pollinate a single ear of corn (Coulter, 1913).[2] Within this time ear worms enter the silk mass, sever some and thereby prevent fertilization of the tip ovules in which case a nubbin results (Pl. 11, fig. 8). Occasionally some kernels missing at the base of the ear may be explained in the same way but this is less common apparently than poorly filled out tips. The silks to the tip ovules are, in general, in the center of the silk mass. The larvæ appear to enter the ear generally through the center of the silk mass, eating as they go. If the larva merely eats in the external silk mass,

[1] Headlee, T. J. Rept. of the Entomologist. N. J. Station Rept., 1913, pp. 633–789, pls. 4, fig. 3.

[2] Coulter, John M. Elementary Studies in Botany. D. Appleton and Co., N. Y. 453 pp., 97 figs. (Corn, 343–351.) 1913.

as is not infrequent, fertilization may not be prevented for as Dr. Taylor further writes, "any portion that emerges beyond the husk is receptive." There are other well known sources of nubbins, but no record has been found of this one in literature. Observations here and in North Carolina indicate that it is of frequent occurence.

The fourth source of loss is the kernels actually eaten (Pl. 11, fig. 7). This varies from a fraction of one per cent to perhaps twenty-five per cent. The number of ears damaged here and southward is frequently 100 per cent.

The larvæ living in the ears and devouring the kernels scatter excrement in the damaged areas to the extent that a repulsive and unsightly condition results (Pl. 11, fig. 4). In the case of sweet corn, many ears are rendered totally unfit for food. Sometimes the damaged portions can be cut off and the ears then used but such ears are manifestly less desirable than uninjured ones. Here is a source of loss of especial importance to growers of sweet corn. Ears of field corn, ear worm-damaged, are usually fed to stock. Haslam (1910)[1] found bacteria of the *Aerogenes* group in this excrement which is recorded as being fatal usually to horses and rabbits when injected into their veins. Such corn is less attractive than perfect ears though the public appears to be largely reconciled to corn thus damaged. The corn exhibited at the corn show at Statesville, N. C., November 23, 1918, manifestly the choice ears of the various crops represented, showed 62 per cent of the ears ear worm-damaged.

Following the ear worm activity on soft corn appear various molds (Pl. 11, fig. 6). These molds not only detract from the appearance of the corn but render the parts thus attacked undesirable for food. Haslam (1910) and others found that symptoms of blind staggers result from feeding moldy corn to horses. *Aspergillus flavus*, *Aspergillus niger*, and *Rhizopus nigricans* are mentioned in this connection. Twenty-four ear worm-damaged ears of field corn, which had been invaded by molds, were submitted to Dr. W. A. Taylor for determination of the molds and the following genera were reported: *Penicillium* (13 ears), *Fusarium* (12 ears), *Cladosporium* (10), *Acrostalagmus* (7), *Rhizopus* (3), and *Verticillium*, *Macrosporium*, *Tricothecium*, *Oospora* (1 each). Though much study remains to be done on the effect of the toxic properties of these and similar molds on domestic animals, it is known that stock, especially horses, sometimes die as a result of being fed on moldy corn.

A seventh source of loss has been entirely overlooked. A very few writers state that ear worm larvæ continue eating corn after it hardens,

[1] Haslam, Thos. P. Meningo-Encephalitis. Kans. State Ag. College Exp. Sta., Dept. of Veterinary Science, Bul. 173, pp. 235–253. 1910. Bib.

the majority, however, failing to mention this feeding habit. A few other writers state that the larvæ forsake the hardening ears for alfalfa, weeds, etc. This latter condition perhaps varies with the locality but here, only a small proportion of the larvæ leaves the hardening ears. Most of the larvæ, especially those half grown and larger, continue feeding on the hardening kernels but their feeding changes in character. In soft corn the entire kernel is devoured (Pl. 11, fig. 7) but this is rare in hard corn. The endosperm part of the kernel hardens first, the germ remaining relatively soft up to harvesting time. The larvæ, therefore, eat the lower part of the kernels, the germ part (Lintner, 1881),[1] often tunneling through a dozen or more (Pl. 11, figs. 4, 9). With the lower part of the kernel gone, the attachment to the cob is also gone so that, during the husking and subsequent handling, these kernels drop out. If the shelled corn under a pile in the field is examined, sometimes as many as one fourth of the kernels will be found to be thus injured. A few more are dislodged when the corn is poured into the wagon as will be seen by examining the shelled corn in the wagon bed. Here is a source of injury often accounting for missing kernels at the tip of the ear and resulting in a complete loss. When the larvæ eat the endosperm of hard kernels, the kernel is largely reduced to corn meal as pointed out by Claypole[2] (1880), also resulting in a total loss.

Finally as French[3] (1882) and many others have indicated, the holes made in the husks by ear worms (Pl. 11, fig. 5) serve as entrance places for other insects which in some cases do considerable damage. In this connection the grain weevils of the south deserve especial mention. Other insects, largely *Coleoptera* and *Diptera* may be found living in the worm excrement and decaying or fermenting kernels which are of lesser economic importance.

It is a difficult matter to weigh in their proper proportions these sources of loss due to ear worm activity. In the light of these considerations there appears to be little doubt that the ear worm is one of the major corn pests at the present time.

EXPLANATION OF PLATE 11

1. An example of "rag worm" injury by the ear worm showing typical damage to the heart leaves.
2. Nearly grown ear worm larva devouring the developing tassel of the stalk of field corn.

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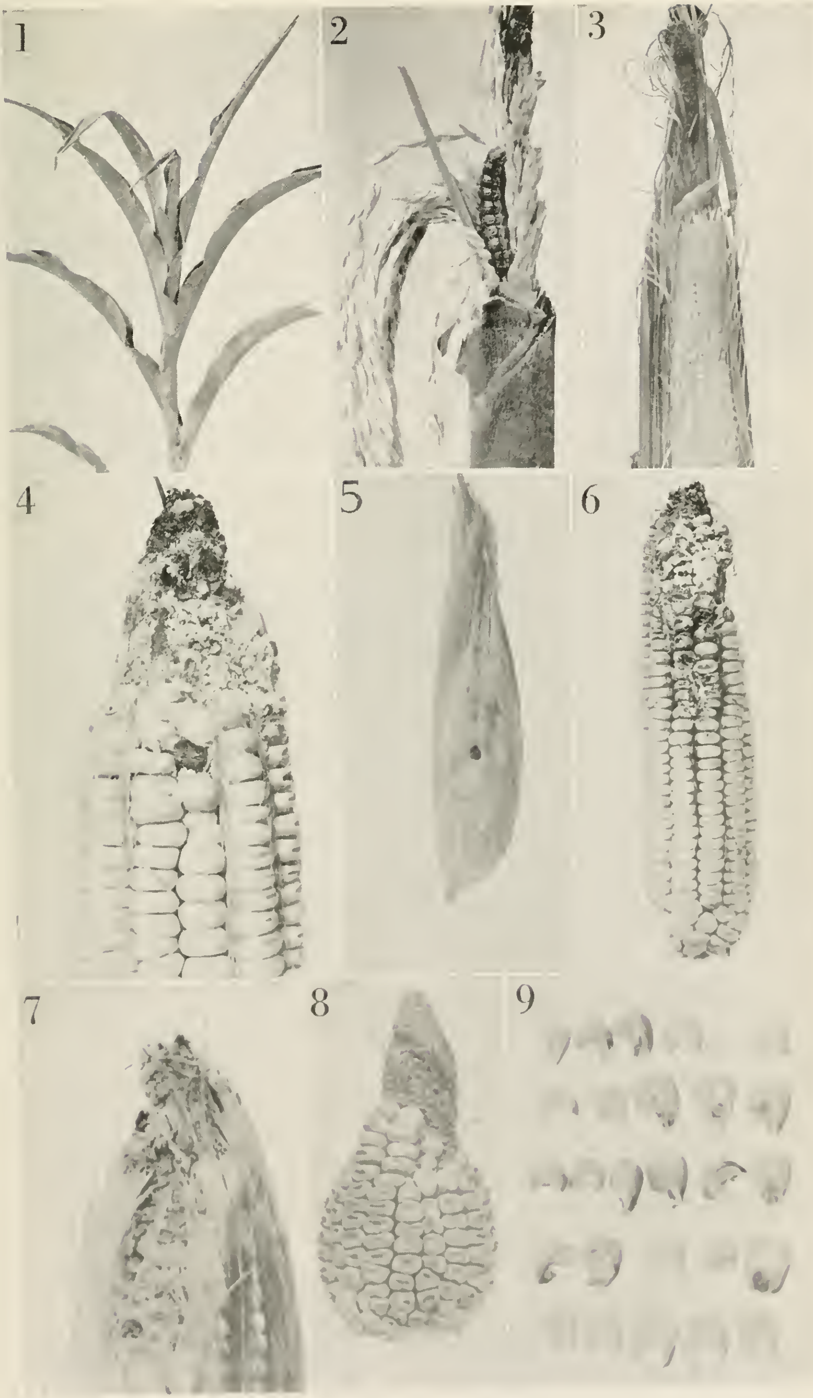
[1] Lintner, J. A. The Corn Worm, *Heliothis armigera*. *Cultivator and Country Gentlemen*, November 24, 1881. Vol. 46, p. 759.

[2] Claypole, E. W. *Heliothis armigera* Feeding on Hard Corn. Amer. Ent. 3 (n. s., vol. 1): 278. 1880.

[3] French, G. H. The Corn Worm or Boll Worm. In the 11th Rept. of the Noxious and Beneficial Insects of Ill., by State Entomologist of Ill., pp. 65–104. 1882.



Ear Worm Injuries

3. Large ear worm larva in tip of ear of sweet corn. Note that many silks leading to tip ovules have been severed.

4. Ear of hardened field corn with its tip ruined by ear worm. Note larval excrement and partly visible ear worm eating the germ part of the kernels.

5. Hole in husk of field corn through which ear worm larva left the ear.

6. An ear of white field corn showing serious side and tip ear worm injury which has been invaded by molds.

7. Severe ear worm injury to tip of ear of Stowell's Evergreen sweet corn showing excrement of larva and how entire kernels are devoured when corn is soft.

8. Nubbin of white field corn apparently caused by ear worm preventing fertilization by destruction of silk. Note furrow on tip of cob where ear worm almost encircled the same, severing the silks as it went.

9. Series of hard kernels of field corn showing ear worm preference for the germ part of the kernel. All kernels shown dropped from the ear when husked or handled.

NOTES ON THE LIFE HISTORY OF THE PINE TUBE MOTH[1] (EULIA PINATUBANA KEARFOTT)

By Albert Hartzell, *Ames, Iowa*

The presence of the larvæ of this insect in injurious numbers on white pine (*Pinus strobus* L.) in the vicinity of Ithaca, N. Y., offered an opportunity to study the habits of this interesting species. The work was done under the direction of Prof. Robert Matheson of Cornell University to whom the writer is deeply indebted for suggestions and criticisms. At the time the work was begun very little was known regarding the life history of the pine tube moth which, until 1905, had been confused with a European species, *Eulia politana* Haw., of widely different habits. The first reference to the pine tube moth was by Comstock[2] in the report of the United States Department of Agriculture for the year 1880. In 1905, Kearfott[3] recognized it as a new species under the name of *Eulia pinatubana.*

The Moth

The adult is a small trim moth with a wing expanse of about 14 mm. The head, fore wings, and thorax are of a rust-red color. The fore wings have two lighter oblique lines crossing them; the hind wings and the dorsal side of the abdomen are silky gray.

The first moth reared by the writer emerged April 13, 1915. The moths continued to emerge under insectary conditions until April 20. From examination of the pupal cases, emergence is accomplished by the splitting of the pupal thorax along the median line, usually as far

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[1] Contribution from the Entomological Laboratory of Cornell University.

[2] 1881. Comstock, J. H. Report of U. S. Comm. Agr., 1880, p. 264–265.

[3] 1905. Kearfott, W. D. Canadian Entomologist, 37: 9–10.

caudad as the first segment of the abdomen. On the ventral surface the rupture is between the maxillæ and the first thoracic pair of legs, thence along the suture between the antennæ and the wing pads.

The moths were first observed in the field by the writer on April 30, 1915. In 1916 they were first seen on April 17. Specimens were captured June 8, 12, 19, and July 15, 1915, and April 17, 1916. All the observations and captures were made at Ithaca, N. Y. In spite of the large number of tubes found on white pine in this vicinity the moths are seldom taken.

Our observations indicate that the moths are crepuscular. In the day time they appear sluggish while at dusk they become active and are extremely hard to follow because of their zig-zag flight. In experiment cages they avoided the intense light of an electric bulb but appeared to be attracted to a mild light. Several trips were made to a near-by pine wood to study their nocturnal habits under natural conditions but the moths were never observed flying except when disturbed. The writer never succeeded in capturing them with trap lanterns. The average length of life as appears from data at hand is approximately eight and one-half days.

Mating and Egglaying

The moths could not be reared in sufficient numbers to make a careful study of their mating and egglaying habits. Copulation was observed once, however, and the time occupied was ten minutes. Females confined to cages were frequently seen pressing the tip of the abdomen against the rib of the pine leaves but all attempts to rear the larvæ from the eggs failed. The writer confirmed the identification of the eggs, however, by the dissection of gravid females.

Description

The Egg.—The egg is translucent, slightly pointed at the apex and rounded on the opposite side. The average length is 4 mm.; width, .58 mm.

The Larva.—The shape of the mature larva is roughly cylindrical; length 8 times the width; color greenish-yellow with an indistinct darker green band along the dorsal median line. The head is greenish-brown and is semi-translucent. The patch on the side of the head is dark brown to black. The head is not depressed. The front extends about three-fourths the distance to the vertical angle. The second adfrontal setigerous puncture is present. There are six ocelli; the second and fourth are larger than the others. The sixth is rather close to the fourth and fifth. Prolegs on the 3rd, 4th, 5th, 6th and 10th abdominal segments. The seta on the distal end of the anal process is at least twice the length of the stalk of the anal process.

Habits of Larvæ

The larvæ are active caterpillars. When disturbed they retreat into their tubes; if unable to return they will let themselves down by

means of a thread spun from the silk glands. Because of their shyness, minute size and protective coloration they are difficult to study in the field.

The larvæ build tubes by drawing together the leaves of the white pine with silk. The leaves are placed longitudinally side by side and are bound together by means of silken threads. From five to twenty leaves are used in its construction. At first the tube consists of five leaves, the number in a single fascicle, but as the larva grows more and more are drawn in to feed upon. Usually two or three are left uneaten which serve to hold the tube in place even when many of the older leaves that constitute it are dead. The larvæ live singly. It was thought probable that the caterpillars may occupy more than one tube during its larval life. From the beginning of the study the writer had noticed that pupæ were commonly found in new tubes. In order to prove that a caterpillar may occupy more than one tube during its larval life, a larva of the last instar was removed from its tube and placed on a pine branch. In a few days the branch was examined and on it was a roughly constructed tube which the larva hastily made prior to pupating.

The first larvæ were observed in the field July 20, 1915. At that time they were 3 mm. in length. The head measurements varied from .282 mm. in the first instar to .848 mm. in the sixth instar.

The Pupa

The pupal skin at first is soft and pliable. The color is greenish-yellow, resembling that of the larva. In eight or ten days the skin hardens and turns brown with a green tint along the wing pads and thorax. Specimens examined October 20, 1915, showed structural resemblances of the mature pupa except that in a number of cases the antennæ were more sharply defined than in the mature specimens.

The pupæ are found in October in the upper ends of the tubes, enveloped in silk. The insect hibernates in the pupal state. That the insect may not invariably pass the winter as a pupa was brought to the writer's attention by the discovery of a live larva in a tube on December 23, 1916.

Number of Generations

It is commonly believed that a second generation occurs in the latitude of central New York. The data gathered in this study indicates that the insect is singly brooded, but more research is needed to establish this fact.

Distribution

The distribution of the pine tube moth is not very well known. Comstock[1] reports that it occurs as far south as Florida; Kearfott,[2] from New Jersey and Ontario, and Packard[3] from Massachusetts and Maine. Probably it is safe to conclude that *Eulia pinatubana* occurs throughout the white pine district of southern Canada and eastern United States.

Host Plants

During this study an examination of the various species of pine in the vicinity of Ithaca, N. Y., was made to determine whether white pine is the only host plant of the larvæ of the pine tube moth. Our observations lead us to conclude that white pine (*Pinus strobus* L.) is the only host plant. Fernald[4] has called attention to the fact that the European *Eulia politana* has never been reported from a single conifer in Europe.

Natural Enemies

In connection with this study twenty-five individual parasites have been bred. A list of these parasites is given in the table, with the dates of emergence. Through the kindness of Dr. L. O. Howard, chief of the Bureau of Entomology, five have been identified to genera and twenty to species. The Chalcids were identified by Mr. A. A. Girault. The remaining parasites were identified by Mr. R. A. Cushman and Mr. S. A. Rohwer. Of the total number seven are larval and eighteen are pupal parasites.

Pupal Parasites

The pupal parasites were bred in connection with the rearing of the adults. In order to breed the moths successfully it is necessary that the pupæ remain undisturbed in the tubes. Mr. Cushman calls attention to the fact that *Eclytus pleuralis* has previously been bred from spider nests and as the parasites in question were not bred from naked pupæ it is probable that they came from a similar source as the tubes are frequently the haunts of small spiders.

Larval Parasites

On October 18, 1915, while engaged in making head measurements of caterpillars the writer observed a larva that appeared sluggish. Thinking that this individual was ready to molt, it was placed in a

[1] 1914. Comstock, J. H., and Anna B. A Manual of the Study of Insects, p. 245.

[2] 1905. Kearfott, W. D. Canadian Entomologist, 37: 10.

[3] 1890. Packard, A. S. 5th Report, U. S. Ent. Comm., p. 791.

[4] 1881. Fernald, C. H. Report of U. S. Comm. Agr., 1880, p. 265.

vial. When examined two days later, nothing but the skin remained and in its place appeared a larval parasite that seemed to be sucking the juices from the remains of the host caterpillar. A second *pinatubana* larva introduced into the vial met with a similar fate. The parasite pupated October 29, 1915. On November 3, the adult appeared. Again on October 18, 1915, another caterpillar was found with two parasitic larvæ attached to the dorsum. October 22, one of the parasites was observed feeding on the host. Only one of these reached maturity. Both the adults referred to above were identified by Mr. R. A. Cushman as *Epiurus alborictus* Cress. These larvæ seem to attack the host just before pupation. It is not uncommon to see two or three eagerly devouring a sluggish caterpillar.

On October 25, 1915, another larva was found attacking a caterpillar. On the 29th of the same month a pupa unlike that of *E. pinatubana* was found in the tube occupying the same relative position as the host pupa normally assumes. It was necessary to open the tube and remove the silk to assure one that it was not the pupa of the pine tube moth. The parasite in question was identified by Mr. S. A. Rohwer as *Phytodietus pleuralis* Cress.

PARASITES OF EULIA PINATUBANA KEARFOTT

Date of Emergence	*Parasitic on*	*Name*	*Identified by*
1915			
1. Apr. 13	pupa	Eurytoma sp.	A. A. Girault
2. " 15	"	"	"
3. " 16	"	"	"
4. " 20	"	Elachistus sp.	"
5. " 15	"	Epiurus indagator (Walsh)	R. A. Cushman
6. " 16	"	Eclytus pleuralis (Prov.)	"
7. " 16	"	" "	"
8. " 16	"	Epiurus indagator (Walsh)	"
9. Nov. 4	larva	Epiurus alborictus (Cress)	"
10. Oct. 29	"	" "	"
11. Dec. 3	"	Phytodietus pleuralis (Cresson)	S. A. Rohwer
12. " 4	pupa	Itoplectis conquisitor (Say)	R. A. Cushman
13. " 4	"	Phytodietus pleuralis (Cresson)	S. A. Rohwer
14. " 19	larva	" "	"
15. " 31	"	Hemiteles sp.	"
16. " 31	pupa (?)	Epiurus alborictus Cr.	R. A. Cushman
17. " 31	"	" "	"
1916			
18. Jan. 18	"	Phytodietus pleuralis (Cresson)	S. A. Rohwer
19. Feb. 7	"	" "	"
20. " 8	"	" "	"
21. Apr. 1	"	" "	"
22. Nov. 29	larva	" "	"
23. Dec. 29	"	" "	"
24. " 29	pupa (?)	Epiurus indagator Cr.	R. A. Cushman
25. May 6	"	" "	"

OBSERVATIONS ON WINGLESS MAY BEETLES

By R. A. Vickery and T. S. Wilson

During the spring of 1918, from April to July, this station received many reports of damage to crops by the wingless May beetles. Two species were injurious, namely, *Lachnosterna cribrosa* and *Lachnosterna farcta*. The former was reported to be injurious to cotton in Bexar County and in other counties in southern Texas, and to wheat in northern Texas. The latter was reported to this station only from Bexar County, the most serious damage being done in and near the city of San Antonio. Both species are very destructive to crops when they occur in large numbers, as they attack young plants and may completely destroy all plants in a large field. Furthermore, they remain numerous long enough to destroy several plantings.

Lachnosterna cribrosa is about one inch long, shiny black in color and wingless. *Lachnosterna farcta* is about the same size but brown in color. The latter species has wings but they are too small to be used in flying. Both species have stout clumsy bodies with distended abdomens.

These beetles remain in the ground during the day and emerge only at night to feed. *Lachnosterna cribrosa* comes out about sundown and remains out for several hours but *L. farcta* comes out after dark and remains out a longer time. Both species are energetic travelers and may be seen wandering about after dark. Their choice of food is limited by their clumsiness and inability to fly, so that they eat almost any vegetation that they can reach. They seem best able to climb plants having small round stems, such as young plants of cotton, bean, Amaranthus, and alfalfa. They usually do not climb high upon the larger plants but feed on the more accessible lower leaves. Both species feign death when disturbed.

In the laboratory these beetles were kept in uncovered wooden boxes 30 inches in length, 16 inches in width, and 12 inches in depth, and they were seldom able to climb out. *Lachnosterna cribrosa* began to emerge from the soil in these boxes about 6.30 p. m., sun time, and had all reëntered the soil by 9.30, but *L. farcta* was still emerging at this hour.

The beetles burrow into the ground to a depth of from four to six inches. They usually enter near the base of the plant upon which they have been feeding. Many often enter near the base of one plant or of a small cluster of plants and they kick up a small mound of pulverized soil, giving the characteristic appearance as shown in figure 3, plate 13. The emergence holes are round and about one-half inch in

diameter which are plainly visible where the ground has not been pulverized by cultivation. Just before sundown *L. cribrosa* may often be observed sitting quietly with the head projecting out of the exit. These holes are shown in the photograph (Fig. 4, pl. 13). These beetles began to emerge in the field about sundown and by 9 o'clock they were out in countless numbers, sometimes as many as five to a single plant.

Lachnosterna farcta

Reports began coming to our office during the latter part of March, 1918, from the people of San Antonio who had gardens attacked by the common large brown June beetle (*Lachnosterna farcta*). By the first of May these beetles were very numerous and the reports of damage were coming to us almost every day. The ravages of this pest were so great that many gardens were replanted several times, the plants being defoliated each time. The gardens in the northern part of the city suffered most.

Many acres of cotton were destroyed by this species in Bexar County and perhaps the damage extends into other counties. In four fields visited the cotton had been completely destroyed in areas of from five to twenty acres. Other fields were damaged in smaller patches.

In one field observed these beetles had finished a fifteen acre tract of cotton and attacked young corn adjacent to the cotton, but as the corn was too large to be destroyed only the lower leaves were damaged.

This species did not entirely disappear until about the middle of July. One beetle was observed in a garden in the northwest part of the city on the night of July 14, and one was caught in a barrier at the United States Entomological Laboratory on July 15.

Food Plants.—Beans seemed to be the favorite food plant of this species in the gardens. As many as four or five beetles fed on a single plant, eating off the leaves and buds and leaving only the stalk. Large numbers of these beetles were observed feeding on Bermuda grass in lawns and in vacant lots at the edge of the city. Among field crops cotton was the favorite. Young plants with two to four leaves were entirely defoliated, causing the stems to die soon afterwards. The older plants suffered considerable damage but were not killed outright. We observed the beetles feeding on corn in the station garden. They usually remained on the ground and fed on the lower leaves which hung down, although a few were observed climbing the young plants.

We observed these beetles feeding on the following plants: Amaranthus spp., beans, beets, Bermuda grass, black eye peas, corn, cotton, cabbage, castor bean, cucumber, fig, grape, lettuce, okra, radish, rape, Russian sunflower, rutabaga, spinach, turnip, and velvet bean.

People who cultivated small gardens reported that the beetles

attacked the plants listed below, besides many of those given above: English peas, eggplant, blackberry, cantaloupe, carrot, onion, peanut, potato, watermelon; and the following flowering plants: candytuft, chrysanthemum, cockscomb, columbine, cornflower, larkspur, marigold, petunia, pinks, poppy, rose, snapdragon, spearmint, sweet pea, verbena and zinnia.

Experiments with Control Measures.—When the complaints first began coming in we recommended the use of light traps. The lights were placed over vessels buried with the tops level with the surface of the ground, some dry and others containing water. Only a few of the beetles were caught by this method.

We also recommended hand-picking. This method has been used by many people in former outbreaks and is effective where only a few of the beetles can migrate into the garden. But it proved to be a tedious and useless remedy for a small garden surrounded by large lawns and vacant lands or other gardens from which the pest could migrate.

The use of bran mash or the application of arsenicals to the plants in powder form or liquid spray would be effective in large market gardens but could not be recommended for use in small gardens because poultry would often have access to the poison or the dead beetles.

We know of one man who protected his plants by means of empty tin cans with both ends removed and placed over the plants.

We found that a barrier made of boards could be used successfully for the protection of small patches of vegetables. Any kind of boards may be used but if narrow they should have one side smooth. The boards should be placed tightly on one edge on the ground with the ends fitting tightly. Vessels are buried with the tops level with the surface of the ground at intervals against the boards, both inside and outside. As the beetles wander about they come to the boards and follow them till they fall into the vessels where they remain. On account of their heavy, clumsy bodies they are able to climb even a rough perpendicular surface only a few inches. They have been observed many times trying to climb a board but nearly always falling back. In a few instances they have been seen to cross a four-inch board. It is impossible for them to escape from buried vessels which have smooth inner surfaces. After a few nights nearly all the beetles were caught from within the barrier but picking some by hand each night would more speedily rid the part inside the barrier from the beetles.

Barrier Experiments.—We constructed seven of these barriers in all as described above. They were all located in the southern part of the city near the laboratory where the beetles were not so numerous as they were in the northern part. The beetles were removed from

the traps every morning and the number recorded. The records of two of these barriers are given here.

Barrier No. 2: This barrier was constructed in a cotton patch in the laboratory garden on May 22, 1918. A plot 20 feet square was inclosed by means of boards 1 inch thick, 4 inches wide, and 20 feet long. On the inside one eight-inch flower pot was placed in each corner. Pots were not placed on the outside until May 23 when one was placed at the middle of each side, and on May 28 one was placed at each outer corner.

A record of the collections made at this barrier is given below. Beetles were collected from May 23 until July 15, 102 being caught on the inside and 953 on outside.

Table Showing Number of *Lachnosterna farcta* Caught in Barrier Number 2

Date 1918	Beetles Inside	Beetles Outside	Total	Date 1918	Beetles Inside	Beetles Outside	Total
May 23	35	0	35	June 19	0	0	0
24	8	90	98	20	0	1	1
25	4	97	101	21	0	5	5
26	4	65	69	22	0	1	1
27	2	73	75	23*	0	0	0
28	5	83	88	24	0	9	9
29	4	91	95	25	0	1	1
30	4	74	78	26	0	2	2
31	3	58	61	27	0	1	1
June 1	1	47	48	28	0	4	4
2	1	23	24	29	0	0	0
3	6	39	45	30	0	0	0
4	0	35	35	July 1	2	0	2
5	1	25	26	2	0	3	3
6	2	13	15	3	0	0	0
7	4	17	21	4*	0	0	0
8	4	13	17	5	0	1	1
9	2	14	16	6	0	0	0
10	4	17	21	7*	0	0	0
11	4	8	12	8	0	1	1
12	0	9	9	9	0	0	0
13	2	11	13	10	0	0	0
14	0	7	7	11	0	1	1
15	0	4	4	12	0	0	0
16*	0	0	0	13	0	0	0
17	0	5	5	14*	0	0	0
18	0	4	4	15	0	1	1
				Total	102	953	1,055

Observations were discontinued on July 23.

* No observations made.

Barrier No. 6: On July 3, 1918, a barrier was constructed around a bean patch, consisting of five rows 150 feet long, located in the south part of San Antonio. This barrier was made of boards 1 inch in thickness and 4 inches in width placed on one edge, fitting tightly on the surface of the ground. The ends were held together by means of pieces of shingle nailed on the top edges and the boards were supported

by pieces of shingle driven into the ground and nailed to the boards. Common tin cans were buried with the tops level with the surface of the ground and against the boards, both inside and outside the barrier. On the inside a can was placed at each corner and twelve cans were placed at intervals along each side. The same number of cans were put on the outside in the corresponding locations. Fifty-six cans were used altogether.

A record of the collections follows. Counts were made from June 4 until June 22, making a total of 371 beetles from the inside and 1,414 from the outside.

TABLE SHOWING NUMBER OF *L. farcta* CAUGHT IN BARRIER NO. 6

Date 1918		No. Caught Inside	No. Caught Outside	Total
June	4	96	109	205
	5	48	149	197
	6	37	137	174
	7	24	84	108
	8	27	72	99
	9	38	102	140
	10	22	62	84
	11	10	34	44
	12	4	40	44
	13	13	29	42
	14	6	20	26
	15	11	42	53
	16	6	40	46
	17	9	23	32
	18	4	16	20
	19	5	27	32
	20	2	29	31
	21	5	12	17
	22	4	16	20
Total		371	1,043	1,414

LACHNOSTERNA CRIBROSA

The first report of damage by this species was received on April 25, 1918, from Mr. Albert Gembler who has a farm about ten miles southeast of San Antonio on the Goliad road. The writers visited this farm and found these beetles there in very large numbers. The field where damage occurred comprises about seventy acres. The soil is loose, sandy loam upland and slopes toward the west and south. There is a strip of brush on the north side and cultivated fields on all the other sides of this field. Cotton was planted in this field and there was a good stand of young plants with from two to four leaves when the outbreak started. The beetles had started work in the highest part of the field and had destroyed the cotton plants in a solid patch of about fifteen acres. The devastated area was roughly circular in shape and it appeared that the beetles had matured in this part of the field.

They were working along the edge of this area and were migrating outward and destroying the cotton as they went. The cotton was planted in rows extending north and south and the beetles seemed to prefer to follow the rows as the heaviest migration was northward. Most of their fresh entrance burrows were found in a strip about five yards wide around the bare area. This strip was also marked by many newly damaged plants.

Here we found the beetles in the soil in very large numbers, often from 6 to 13 in one foot length of the cotton row. Beetles were found in all parts of the field in small numbers and a few in the brush on the north side of the field where they had probably migrated from the infested part of the field.

By the latter part of June the beetles had almost disappeared. It was estimated that a total of about forty acres of cotton was destroyed, aggregating a loss of about $2,000.

FOOD PLANTS.—These beetles were observed in the field feeding on cotton, beans, corn, and sorghum; and on Russian sunflower in the laboratory garden. In the laboratory cages they were fed on Amaranthus and alfalfa. Both of these plants were eaten readily. They ate of the corn leaves which were put into the cages but did not relish this plant. Cotton was the favorite food plant in the field. These beetles were sometimes seen nibbling on the leaves of young *Panicum fasciculatum reticulatum* Torr. However, this grass apparently did not suit their taste as the plants were left in the rows where the cotton had been completely destroyed.

EXPERIMENTS WITH CONTROL MEASURES.—Large quantities of the beetles were hand-picked at night and killed by means of kerosene by the Gembler family. But on account of the extremely large numbers this process was not only a tedious one but almost ineffective.

On April 25 we prepared three pounds of bran mash and scattered in this cotton field where the beetles were numerous. The mash was made according to the following formula:

Wheat bran	24 pounds
London Purple	1¼ pounds
Syrup	2 quarts

On the following evening several dead beetles were found in this spot on top and in the soil and several others apparently too sick to move or feed. In some instances the poison took effect after the beetles had entered the soil. More dead ones were found the second day after the poison was put out than the first day afterwards.

Two more batches of poison bait were put out on April 27, prepared according to the following formulæ:

Wheat bran	24 pounds
Paris green	1 pound
Oil of anise	1 ounce

Corn bran	24 pounds
Paris green	1 pound
Syrup	1½ quarts

This poison bait was put out about 6 p. m., scattered by hand in the cotton rows. At 9 o'clock a large number of beetles were feeding on the bait. Only a few were seen feeding on that made of corn bran but many on the wheat bran mash. Later observations showed that a large number of beetles were killed by the latter and only a few by the former.

Encouraged by the results of the previous experiments Mr. Gembler began putting out bait made according to the following formula:

Wheat bran	20 pounds
Paris green	1 pound
Syrup	1 quart
Lemons	3

He scattered twenty pounds of this mixture each evening about sundown as it was found that this was the best time because the material dried out rapidly. There seemed to be some advantage in mixing the bait the day before it was to be used, thus allowing the poison to become more thoroughly soaked into the bran. From two to three acres could be covered by twenty pounds of the bait. The best results were obtained by putting it in the patches where the beetles were most numerous as indicated by the exit and entrance holes.

Excellent results came from the use of this poison bait for large numbers of dead beetles were to be found where it was used. In some places from five to eight dead were found on top of the ground in a space the size of a man's hand. A large percentage also died after entering the soil and many were found dead where they had crawled several yards from where they had eaten of the poison. Twelve counts were made in different parts of the field, each count measuring twenty yards in length of the cotton row. The dead beetles in these spaces ranged from 15 to 60 in number, averaging 32 to each count. The records were made during the evening about 6 o'clock and only two of these places had live beetles, one had one and another three crawling about. These counts did not include those which had died after entering the soil.

Mr. Gembler substituted one teaspoonful of anise oil in some of the bait and according to his observations the species preferred it to that

flavored with lemon juice. He states that the beetles would often leave the cotton plants to feed on this bait.

A few rows of cotton were dusted with powdered arsenate of lead. A large number of the beetles were killed by this means also. But it was found that the arsenate of lead used as a spray, two ounces to three gallons of water, was more economical. This spray was used effectively to help stop the advancing pest, and thus saving part of the cotton. This and the poison bait saved several acres of cotton on one side of the field while on the other side, where poison was not utilized, it was destroyed to the fence.

During July we investigated damage done by *Lachnosterna cribrosa* in San Patricio County. We found that it had been numerous and had done serious damage to cotton there also. The following letter from Mr. T. C. Cobb, who is county agent of that county, tells of the methods used to combat the beetles. This letter bearing the date July 17, 1918, reads:

Dear Sir:

Having had considerable experience this season in fighting wingless May beetles I am glad to report the results of the methods employed in this county.

In the first place I wish to state that the beetle was here in countless numbers, completely destroying in one instance a hundred-acre block of cotton, as well as doing considerable damage on smaller scale in several other fields.

We tried various methods, including poisoned bran mash, dusting poison on the cotton plants, hand-picking, but the best work was with the barrier ditches. These were made by running several times in the same furrow with a lister, making a loose steep-sided, deep furrow. The perpendicular-sided furrow was not successful because the beetles could climb out on the hard dirt, while the loose dirt would roll down with them when they tried to climb out of this. After plowing the furrow as deep as necessary with the lister the bottom was smoothed out with a shovel so the beetles could easily walk along the bottom. In this smooth part postholes were dug about fifteen or twenty feet apart, into which the beetles fell and were destroyed.

A little different plan than that which has been suggested is to leave off the digging of holes in the bottom of the furrow, and patrol the furrow with a pear burner during the time the beetles travel, which is only late in the evening. I believe this would be just as effective as any other method although we didn't try it this year.

There is no doubt that this beetle can be controlled so as to prevent serious damage with the barrier ditch if the work is done in time, and the beetle is coming into the cotton from outside. In case the beetle hatches in the cotton field I believe the bran mash poisoning would be the most effective means of control, several farmers in this county reporting absolutely satisfactory results from this method.

Yours very truly,

(Signed) T. C. Cobb, *County Agent,*
San Patricio County, Texas.

Recommendations for Control of Wingless May Beetles

1. *In Gardens*

The use of a barrier is the only practical method of controlling these beetles in a small garden. This should be made as described under *Lachnosterna farcta*. In some cases where the beetles are known to come into the garden from one direction a barrier on that side will be sufficient with the aid of hand-picking at night. When the beetles are gathered they should be saved for the chickens. If it is necessary to buy lumber for the barrier, boards 1 by 4 inches and 20 feet long are cheapest and would be satisfactory. Tin cans, with the bottoms melted out, may be used to protect a few of the most valuable young plants. They should be placed over the plants about sundown and removed in the morning.

In large market gardens the seed beds should be protected by a barrier. The plants which are already started in the field should be sprayed or dusted with arsenicals. In case the beetles are very numerous the poison bran mash should be used. If a heavy migration from outside should occur, a deep furrow should be made and bran mash distributed on both sides of the furrow and among the plants nearest the furrow.

2. *In Field Crops*

When the outbreak originates in the field and the beetles are very numerous the infested area should be treated immediately with bran mash. This bait should be broadcasted all over the infested part. This can be done most easily by two men with a single horse and buggy or light wagon. Also a small quantity of the poison bait should be placed at each entrance hole or group of entrance holes at the edges of the infested area. The latter method should also be used where the beetles are scattered in small numbers throughout the field, for although the beetles may not be numerous enough to destroy the stand, it is important to get rid of them before they lay eggs. If the infested area is given one thorough treatment with the poison bait it should be safe to replant in case the stand has been destroyed. When the plants are larger, for instance cotton plants about six inches high, the arsenical should be applied directly to the plants. This could be done very economically with a horse-drawn traction operated potato sprayer, and would also give protection against such insects as *Feltia* spp., *Prodenia* spp., and *Loxostege similalis*.

Where it is desired to protect a field from a heavy migration of beetles, originating in an adjoining field, a furrow barrier should be made. Bran mash should be distributed on both sides of the barrier and among the plants near it. If the plants near the furrow are large enough to be poisoned an arsenical should be applied to them.

Fig. 1.

Fig. 2 Fig. 3.

Wingless May Beetles

Fig. 1.

Fig. 2

Fig. 3.

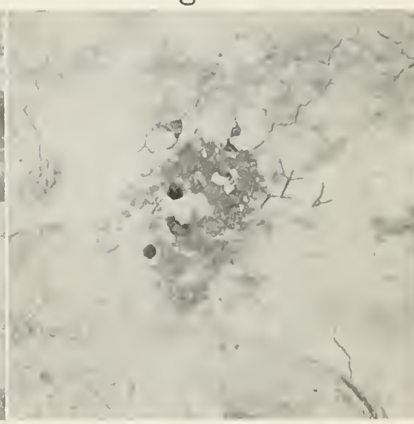

Fig. 4.

Fig. 5.

Wingless May Beetles Work

Explanation of Plates

Plate 12

Fig. 1. Barrier for the protection of plants from *Lachnosterna farcta* See text under Barrier No. 2.
Fig. 2. *Lachnosterna farcta*, x2.
Fig. 3. *Lachnosterna cribrosa*, x2.

Plate 13

Fig. 1. *Lachnosterna cribrosa* beetles finishing a few cotton plants.
Fig. 2. A defoliated plant and emergence holes of the beetles. One beetle just emerged.
Fig. 3. Shows a typical group of entrance burrows at the base of a cotton plant.
Fig. 4. Another view showing soil kicked up by the beetles when entering the ground and emergence holes of the beetles near three defoliated plants.
Fig. 5. Flashlight of the beetles at work on cotton plants.

JAPANESE FLOWER BEETLE

By W. H. Goodwin

Some ten miles northeast of Camden, and a few miles back from the Delaware River opposite Tacony, North Philadelphia, is the location where the Japanese flower beetle has become established, temporarily at least. The infested territory lies between Moorestown and Riverton, N. J., and at present covers some four or five thousand acres of very productive sandy loam farms. The country is gently rolling and the greatest altitude is not over one hundred feet above sea level. It is drained by small creeks but the entire area lies between the two larger streams, Pensauken and Rancocas creeks. Farming in this district is intensive; the principal crops, excepting for a small amount of general farm crops, are such truck crops as tomatoes, sweet corn, asparagus, peas, and beans, which find a ready market in the city. Peaches, apples, pears, and cherries do well in this locality and are quite extensively grown.

The soil varies greatly in texture and general mechanical composition, varying from a rather stiff heavy clay soil to almost pure sand. Sometimes these extremes in soil variation occur within the comparatively short distance of only a few rods.

These principal soils are known as Sassafras, Freneau, and Elkton loams with a few small areas of other types.

The people are largely Quakers and, I take it, are descendents of the early settlers of this district.

In April, 1918, final action was taken to begin active steps for the eradication of this newly acclimated pest, for pest it is, as the meager

reports from Japan class it as doing more general damage than any other species of the coleoptera in the Islands.

In New Jersey it has seemingly not lost its reputation as a pest.

From the survey made by Mr. W. O. Ellis, after the 18th of August, 1917, the range of territory occupied by this beetle was about 2,500 acres. This does not mean that the pest was actually established over this entire area, but beetles were collected at various points over an area of this extent.

Upon my arrival, May 1, 1918, the only equipment available for eradication work was a small cart sprayer, a barrel sprayer and two large D1 Model Niagara dusters and a ton of arsenate of lead.

Working plans were necessary and were prepared after carefully looking over the territory and the conditions which would be encountered.

Plans

First: To test soil fumigants and choose the best suited for the existing conditions. Procure the same in a sufficient quantity to treat all territory heavily infested with the larvæ of the Japanese flower beetle to destroy them.

Second: To place trap lights throughout the central portion of the district to trap the beetles. A translation from the life history, as given in the Japanese writings, states that they are caught by setting a lighted lantern in a pan of petrol.

Third: To destroy all uneconomic plants in so far as possible in a band around the infested territory, band to be about one half mile wide.

Fourth: To dust all food plants with poison, especially a broad band of territory surrounding the central portion of the infested district.

Fifth: To collect as many beetles as possible in nets.

Sixth: To test cultivation throughout the season and late fall plowing to determine its effect on the larvæ.

The plans for eradication work encountered many difficulties from the beginning. The equipment needed included a large sprayer, two large dusters, a tractor, a light truck, and necessary machines to get around over the territory and transport men and materials wherever required.

Intelligent labor of the type needed was difficult to secure. Horsepower was at a premium and very difficult to obtain at the times most needed.

A larval survey was necessary in order to determine the areas which should receive soil treatment to destroy the larvæ, meanwhile experiments were under way testing the efficiency of various soil fumigants. Sodium cyanide at the rate of 1 ounce in 15 gallons of water distributed over twenty-five square feet of ground gave the best results.

We (Mr. Ellis and I) were anxious to get the results and dug the test plots two to three days after treatment. A kill of 65 to 80 per cent resulted from this treatment.

Plots treated later on in the season (duplicate halves of others) in which the kill averaged to 60 to 65 per cent of all grubs 3 days after treated; when dug six to seven days after treatment gave an increase of approximately 15 per cent to 20 per cent in effectiveness, killing 80 to 90 per cent of the stages in soil.

The partial larval survey, made by C. A. Perry and myself, gave us ample territory that was heavily infested with larvæ to be treated but no materials or equipment had arrived by mid-June. Trap light towers were constructed, gasoline lanterns and pans were purchased and these were put in place through the central part of the district. Counts of beetles caught in the pans by the latter part of July gave an average of less than 20 beetles per lamp where the lamps were kept burning every night. Several towers fully equipped, but which did not have the lanterns lit on account of failing to catch beetles, averaged above 250 beetles per tower. The trap lanterns were a failure; some one had made a bad recommendation, if we can rely on the translation from the Japanese literature or else we have a change in habits of the beetles. Such things sometimes make one question species indentification.

As no more equipment or materials had arrived by June 20, 1918, steps were taken to get the eradication work under way. A Ford runabout had been purchased at New Brunswick and, through Dr. Headlee, we secured a small supply of sodium cyanide at Perth Amboy and brought it to the scene of operation in the Ford. The Ford was provided with a hundred-gallon gasoline tank and a fair capacity force pump was borrowed and belted to the engine on one of the duster trucks.

This was used to pump water from a creek and the cyanide treatment was begun.

A small beginning but under way finally, enabling the treating of between one and one-half and two acres of sod land, along ditches and roads, that was heavily infested with larvæ. June had passed into history, also eight days of July before the tractor arrived by express. The sprayer also arrived, but with some parts broken, so it had to be repaired before it could be used.

Oil and oil combinations had been tested in a small way as weed killers as the things ordinarily used were dangerous to live stock if they ate the treated grass or plants. Kerosene, alone, was ineffective but a mixture of cheap lubricating or summer black oil, using equal parts or 2 or 3 parts kerosene to 1 of black oil, gave promising results.

Fence rows full of poison ivy, sassafras, and weeds, food plants of the beetle were killed or could be set on fire and burned on warm breezy afternoons, even two or three days after they were sprayed.

Fire following the spraying does a clean job, but as oil could not be procured after July 1, due to the dry rider on the federal appropriation bill holding up available funds for this work, and New Jersey's funds for this work being appropriated, contingent to the use of the federal funds first, operations were handicapped for several months and oil treatment was abandoned.

A limited amount of federal funds were available for labor or the work would have stopped.

Dusting all food plants in a band one-half to one mile wide around the territory heavily infested by the beetles was begun July 14, and continued through July, August, and until September 16. One big Niagara dusting machine, pulled by the tractor, was in operation continuously, weather permitting, and as rain usually fell at night little hindrance was experienced from weather. When one duster went out of commission, the other one was pressed into service until the broken one could be repaired.

One hundred pounds of lime was mixed with 15 pounds of dry arsenate of lead and in a small dust mixing machine. Later, the amount of arsenate of lead was increased to 20 pounds to 100 pounds of lime.

The last few days of the dusting, 24 pounds of arsenate to 100 pounds of lime was used as a test on amounts of poison needed. The acreage dusted cannot be estimated with any exactness but the total territory covered in the dusting operations can be estimated approximately:

First treatment	4,000–4,500	acres
Second treatment	4,500–5,000	"
Third treatment	4,000–4,500	"
Fourth partial treatment	1,000	"
	13,500–15,000	"

Total area dusted, 13,500 to 15,000 acres which includes large tracts on which no dusting was done, such as hay fields, pasture lots and fields free from food plants of the beetle.

Difficulty was experienced in dusting the area rapidly enough to keep the food plants covered with poison. Weeds grow rapidly and Polygonum or smartweed and other weeds grow very rapidly during July and August. Dead beetles were found under poison-dusted asparagus and smartweed at different times throughout the season but in most cases, the effective kill was difficult to determine as poisoned beetles usually had enough strength left to bury themselves in the ground.

This made them almost impossible to find after they had eaten leaves of the dusted food plants.

Hand collecting was practiced throughout the season from July 1 to mid-September. Average catches for the day varied with the locality collected and with weather conditions. Collections made largely after 6.30 p. m. from July 5 to July 20 by Mr. Perry and myself totalled almost fifty quarts. Collections by the boys employed for this purpose and under Mr. Spayd's direction varied considerably, but the total season's catch was a little over four bushels of beetles. Counts of measured quarts ranged from 4,400 to 5,000 beetles to the quart or 150,000 to the bushel.

Fall treatment of the soil to destroy the larvæ by using cyanide of a strength of 1 ounce of NaCN in 12 gallons of water began the 16th of September, using the Ford and 100 gallon gasoline tank. Some momentous events happened preventing me from being on the ground during October excepting for a few days during the latter part of the month. Under Dr. Headlee's general direction Mr. W. O. Ellis took charge of the eradication work during my absence. A two-ton truck which had been wanted since June 1 arrived during October and a 600-gallon tank was secured and mounted on it, enabling the treating of one-third to one-half acre of land per day with sodium cyanide solution with this outfit. A street-sprinkling outfit was hired and the tractor and sprayer truck and tank was also put into service enabling the treating of three-fourths to one acre per day with the entire equipment.

Approximately seventeen acres of land was treated with the solution of sodium cyanide applying 15,000 to 25,000 gallons to the acre.

This includes the sod or grassy edges of drives, along roads, ditches, and several small fields of corn ground and grass land.

Normal rates of applying this sodium cyanide solution would require 110 pounds of sodium cyanide to the acre. Some territory treated this fall undoubtedly did not receive much over half of this amount per acre as the failure to get a kill on some fields indicated. A total of eleven acres should have used our entire stock of sodium cyanide, while between sixteen and seventeen acres were treated.

During the latter part of November, we borrowed a gang plow, hitched it to the tractor and plowed between seven and eight acres of land heavily infested with larvæ to determine if possible the effect of such treatment on the larvæ. These plots of land are of several different types of soil and had been cropped in clover, grass, rye, corn, parsley, weeds, and sod along ditches. Most of the ground was plowed 8 inches deep, but some small plots were plowed 12 to 14 inches deep. The 12–20 tractor handled the plows at this depth after four months of continuous service in this sandy region. Without this machine we

would have been compelled to abandon most of the work planned out in the spring, that required the use of horses for power.

The season's field operations closed with this work but all equipment is being overhauled and put in first-class running condition for the coming year's work. Also new equipment is being secured for use next spring.

Concerning the actual progress in the eradication of this pest during the past summer, I can only say that we have materially reduced the numbers there would have been had they been allowed to go on breeding unhindered. The data for comparison with last season is not sufficient as yet to pass judgment. True we have the beetle survey of 1917 after the 18th of August as made by Mr. Ellis and the beetle survey of this season from July 1 to frost. This indicates some spread but the survey map of beetle distribution up to August 10th, 1918, marks nearly the widest limit of this year's range of distribution in so far as I can determine.

The larval survey of last June will not bear comparison with a survey made during October and November, 1918, for according to Mr. Ellis larvæ were present in the fall of 1917 in considerable numbers where none or very few could be found last spring. Furthermore we did not make a complete survey of the entire district supposed to be infested by the beetle. Not until a thorough larval survey is made in the spring of 1919 can a definite statement be made and even then seasonal variation may explain many differences.

Lack of proper and sufficient equipment on the ground in time to permit accomplishing more than part of the necessary eradication work, together with shortage of expendable funds at the time they were most needed, prevented getting the best results—in fact almost blocked the season's work.

VARIATIONS IN THE LENGTH OF THE FLAXSEED STAGE OF THE HESSIAN FLY[1]

By James W. McColloch, *Associate Entomologist, Kansas Agricultural Experiment Station*

A knowledge of the length of the flaxseed stage is of great importance in the development of a system of control for Hessian fly. It is in this stage that the fly withstands extreme conditions, such as excessive heat and drought of summer, and prolonged cold of winter. There is relatively little published data on the length of this stage,

[1] Contribution No. 40 from the Entomological Laboratory, Kansas State Agricultural College. This paper embodies some of the results obtained in the prosecution of project No. 8 of the Experiment Station.

although most of the writers recognize that a great variation exists. Enoch[1] (pp. 350–351) reports rearing flies from barley screenings that had been held two years in dry surroundings. Marchal,[2] in his work in France, was able to rear six broods of flies in the course of a year. He found that most of these broods were partial and that there was a tendency for some of the flaxseed of each generation to hold over until a latter generation. He advanced the idea that the species is perpetuated, in spite of the obstacles placed in its way by exterior conditions, by the great variability of its biologic cycle. Webster (p. 261),[3] quoting from Lindemann, says that the puparia (in Russia) are greatly influenced by environment, temperature, etc., and this is probably true of the other stages. Flaxseed collected by Lindemann in the spring of one year lived over to the spring of the following year. How far the number of these interlopers is augmented by a retarded development of greater or less extent it is impossible to say, but that there is an accession through this means there can be no doubt. Marlatt (p. 2)[4] states that under exceptional conditions the insect may remain dormant in the flaxseed state for a year or more and still bring forth the adult, a provision of nature which is doubtless intended to prevent the accidental extermination of the species. Webster (p. 11)[5] says, "Under exceptional conditions, such as in a dry room, flaxseed may be kept for a year or, even two, but when moistened the flies will soon emerge. So in the fields they will, during a drought, remain in the flaxseed state for a considerable time after they would appear under normal conditions, and only appear soon after rains have moistened the soil." Numerous other writers make similar statements, but data on actual rearings are very meager.

During the past six years much of the writer's time has been spent in a study of the life economy of the Hessian fly under Kansas conditions. Numerous rearings have been made in the field, in the breeding chambers of the air conditioning machine described by Dean and Nabours,[6] in the field insectary and from fly-infested material collected

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[1] Enoch, F. 1891. The Life History of the Hessian Fly, *Cecidomyia destructor*, Say. Trans. Ent. Soc., London, for 1891, pp. 329–366.

[2] Marchal, Paul. 1897. Les Cecidomyia des Céréales et leurs Parasites. Ann. Soc. Ent. France, Premiere trimestre, 1–105.

[3] Webster, F. M. 1899. The Hessian Fly. Ohio Agri. Exp. Sta., Bul. 107, pp. 257–288.

[4] Marlatt, C. L. 1900. The Hessian Fly. U. S. Dept. Agri., Div. Ent., Cir. 12, pp. 1–4.

[5] Webster, F. M. 1906. The Hessian Fly. U. S. Dept. Agri., Bur. Ent., Cir. 70, pp. 1–16.

[6] Dean, G. A., and Nabours, R. K. 1915. A New Air Conditioning Apparatus. Journ. Econ. Ent., 8: 107–111.

in the field. It is not the purpose of this paper to go into detail concerning the experimental work, since it is planned to present the complete studies in bulletin form at some future time. Certain points, especially with regard to the length of the flaxseed stage, seem to be of enough importance to warrant publication at this time as they have a direct bearing on the control of this insect.

The results of these studies show that the length of the various stages of the Hessian fly are extremely variable and consequently there is a great variation in the length of the life cycle. The exact length of the life cycle has been determined for over 900 individuals and the approximate length has been found for 8,500. While variations have occurred in each stage (Table 1), the greatest difference has been in the flaxseed stage where it has ranged from 7 days to 1,083 days. The minimum life cycle of 20 days was obtained under a constant temperature of 70° and humidity of 70 per cent, while the maximum cycle of 42 months was the result of studies in the field insectary and rearings from infested material kept in emergence boxes.

Table 1. Showing the Extremes of the Life Cycle

Stage	Maximum	Minimum
Egg	12 days	3 days
Larva	182 days	9 days
Flaxseed	1,083 days	7 days
Adult	6 days	4 hours
Life cycle	1,283 days	20 days

In order to determine the length of the flaxseed stage, under field conditions, clumps of infested wheat or stubble were collected at all seasons of the year from various localities of the state and placed in pasteboard rearing boxes. Each box had at least one glass tube into which the flies were attracted by the light on emerging. These boxes were kept in the field insectary under practically natural temperature conditions. The moisture, however, varied from that in the field. The material was thoroughly moistened when placed in the boxes. It was also moistened three times during each year: (1) in the spring when the first spring rains occurred; (2) in midsummer, and (3) in the fall when the fall rains began. Being of pasteboard, the boxes also absorbed some of the atmospheric moisture and they were also subject to wetting by beating rains. In all, over 150 collections of infested material have been under observation, and most of the material has been held for at least three years before being discarded.

While the data obtained in such an experiment can only be approximate, it has yielded some very interesting results. The fact that this

material was collected in the field makes it impossible to know the age of the flaxseed at the time they were included in the experiment, and the data are, therefore, summarized, in Table 2, to show the number of days between collection and emergence. Flies to the number of 7,461 were reared from this collected material and the average time between collection and emergence was 113.2 days, with extremes of 2 days and 1,083 days. It will be noticed that 5,114 flies, or 68.4 per cent, emerged during the first month, and 7,385, or 98.9 per cent, during the first year. On the other hand, 1.1 per cent of the flies did not emerge until after the first year, although they were subjected to the same conditions. If such conditions prevail in the field, and 1 per cent of the flaxseed hold over from one to three years, it serves to explain the sudden appearance of the fly in some areas where it was thought to be eliminated, and it emphasizes the importance of taking care of all stubble fields. Experiments are now being conducted to determine whether the fly does hold over for such long periods in the field. Thus far flies have been reared in fairly large numbers from stubble that has stood undisturbed for eighteen months in the field. Living flaxseed are still to be found in this stubble, indicating that further emergence may occur during the spring of 1919.

Table 2. Showing the Period Between Collection and Emergence of Flies

Days After Collection	No. Flies Emerging	Days After Collection	No. Flies Emerging
1– 29	5,114	390–419	1
30– 59	399	420–449	2
60– 89	78	450–479	3
90–119	525	480–509	14
120–149	268	510–539	15
150–179	571	540–569	0
180–209	106	570–599	1
210–239	21	600–629	0
240–269	2	630–659	9
270–299	32	660–689	3
300–329	191	690–719	6
330–359	78	720–809	0
360–389	15	810–839	6
		1,083	1
		Total	7,461

Note: On May 7, 1919, the writer reared a female Hessian fly from a clump of wheat collected May 8, 1915. Allowing approximately a month for the fly to reach the flaxseed stage, this gives a life cycle of at least 49 months.

DOES BORDEAUX MIXTURE REPEL THE POTATO LEAFHOPPER?

By Charles L. Fluke, Jr., *University of Wisconsin*

At various times in the past the attention of our entomologists has been called to serious outbreaks of the potato leafhopper and for many years a more or less serious trouble has occurred on potatoes known as tip burn. A serious outbreak of the latter trouble appeared throughout a part of the country in 1918. This trouble happened in Wisconsin to such an extent as to decrease the potato crop at least 25 per cent. The potato leafhopper was also extremely abundant and observations have shown that the burning was always worse in the presence of a notable number of leafhoppers. It then became easy to associate the tip burn injury of this year with the leafhoppers and many observations were made in this connection. While carrying on experiments with Bordeaux mixture in combination with certain arsenicals for the control of the potato beetle, it was noticed that the plants sprayed with Bordeaux mixture were abnormally free from tip burn. Observations made at the time also showed that the leafhoppers were not abundant on these plants. Thirty plots in all were used in a series to test out various insecticides on Early Triumphs and Rural New Yorkers.

The first application of spray was put on July 10 at which time the plants were in good condition to show the effect of the insecticides. No curling or darkening of the leaves was apparent at this time, and it happened that only one plot of Early Triumphs received a Bordeaux combination spray. The other plots on which Bordeaux combinations were used were late potatoes. Daily observations were carried on to note the effect of these sprays on the foliage. Three days afterward (July 13) a peculiar darkening, not a drying, of the edges and tips of the leaves of the early potatoes was noticed on some of the plots which at first appeared to be due to the action of the spray until it was noticed that this also occurred on the check plots. At the same time considerable curling of the leaves was also observed. A few days later the characteristic burning of the leaves appeared on most of the Triumph plots. The only one which showed very little of the browning was one plot of four rows sprayed with zinc arsenite plus Bordeaux mixture 4–4–50. On July 23 a careful examination of the vines revealed the fact that the leafhoppers were extremely numerous wherever the tip burn was evident. On the above mentioned Bordeaux zinc plot the number of hoppers was comparatively smaller. It was plainly evident that the leafhoppers were very likely the cause of the tip burning and also that Bordeaux mixture had some repellent effect upon the hoppers. The counts were made on July 31 and August 1. The leafhoppers were more abundant on the sprayed plants in the rows next to those

unsprayed, than they were on sprayed plants which were at least six or eight feet away from the check plots.

It should be noted that by August first the check plants of the Early potatoes were in an advanced stage of tip burn while the Bordeaux zinc plot was still healthy with but little tip burning. This plot held up from a week to two weeks longer than the others. When the counts were made the hoppers on these plants were nearly all in the first instar. Of the late varieties there was a decided difference in appearance between the checks and those receiving Bordeaux mixture, the latter vines appearing much healthier. Tip burn appeared in a greater or less degree on all the plants but showed most on the early checks. In all cases the plants sprayed with Bordeaux mixture were healthier and gave higher yields than did the checks or those receiving Black Leaf 40. The nicotine sulfate, however, failed to kill the leafhoppers due mostly to the curling of the leaves. Further experimentation is needed to prove the repelling action of Bordeaux on the leafhoppers but these few observations are given to show future possibilities.

Spray Tests Against the Potato Leafhopper, 1918

Plot No.	Insecticide		Material Added		Date of Application	Variety	Counts		Results		
	Name	Rate	Name	Rate			Nymphs	Adults	Total Hoppers	General Results	Remarks
6a	Bordeaux	4-4-50	Calcium arsenate	2½-50	July 10 and July 27	Late Rurals	162	7	169	Very little tip burning until late in season	Plant 3 feet from checks
6b	"	"	"	"	"	"	82	3	85	"	Plant 20 feet from checks
13a	"	"	Zinc arsenite	"	"	Early Triumphs	175	2	177	July 25—In much better condition than checks. Aug. 1 beginning to show tip burn	Hoppers nearly all just hatched. Next to check
13b	"	"	"	"	"	"	28	8	36	"	6 feet from checks
22	"	"	Lead arsenate	"	July 24	"	9	0	9	Spray applied late still in better condition Aug. 1 than plot 21	Next to plot 21
21	Black Leaf 40	23cc. to 5 gals.	"	"	"	"	335	35	370	B. L. 40 killed very few hoppers due to curled leaves	Next to plot 22. Tip burn severe
30	Check					Rurals	421	47	468	Tip burn appeared about Aug. 1-5	3 feet from early potatoes
31	"					"	177	19	196	"	20 feet from early potatoes
32	"					Early Triumphs	496	46	542	All died early	Next to sprayed vines
33	"					"	260	35	295	"	8 feet from sprayed vines

Total hoppers counted on 5 sprayed plants 476
Total hoppers counted on 5 unsprayed plants 1,871

NOTES ON LEPIDOPTEROUS BORERS FOUND IN PLANTS, WITH SPECIAL REFERENCE TO THE EUROPEAN CORN BORER

By Edna Mosher

The advent of the European corn borer, with its tremendous possibilities for injury if ever introduced into the great corn-growing states, has caused us to become much more concerned about the identity of the various caterpillars found feeding inside the parts of plants. The identity of the plant gives little help in this connection, since the corn borer has a very wide range of food plants and seems anxious to add to the list of those already known. Since lepidopterous larvæ vary considerably in their different stages as to colors and color patterns, and there are many with black or brown prothoracic shields and similar colors at the bases of the setæ, it is necessary to go farther than this in their identification. Easy keys are not available for the identification of such species and this paper is offered in the hope that it may aid field workers and others to be reasonably certain whether or not they have found the European corn borer. Of course the matter would be greatly simplified if we could include all the known species of borers in this country, but since material for such a study is now impossible to obtain, let us hope that our search for corn borers will bring to light, not only species hitherto described, but new life histories as well. It is appalling to think how little we know of the life histories, parasites, etc., of this single genus Pyrausta, whose one renegade member is costing us, not only great amounts of money but a great deal of time and anxiety as well.

Classification of Borers

Lepidopterous borers, in the main, belong to a few families. Nearly all of the species are provided with five pairs of prolegs, four abdominal and one anal, and these are armed with chitinous hooks or crochets. When these are absent the adfrontal area (Fig. 13, no. 29, *adf.*) and the median spine-like spinneret on the labium will distinguish them from larvæ of any other order. This paper does not include leaf-miners, borers in woody plants, or gall-making species.

The character found most reliable so far in the determination of lepidopterous larvæ is the arrangement of setæ on the various body segments. Some other characters have been used, and it seems quite possible that there are others available. In separating the families mentioned here, the arrangement of setæ on the prothorax and of the hooks on the prolegs are sufficient for the majority of cases. The

prothorax nearly always has a chitinized shield on the dorsum which, in most species, does not extend as far ventrad as the spiracle. This area of the thorax properly has six setæ on each side, two of these, one cephalic (seta I) and one caudal (seta II) are usually quite near the median line. The figures show the left side of the prothorax from the median line of the dorsum to that of the venter. Beside these dorsal setæ is a group found nearly always between the spiracle and the cephalic margin of the segment, but sometimes a little ventrad of the spiracle. Farther ventrad is a group, usually of two setæ, between the spiracular group and the coxa. Near the coxæ, usually between them and the median line of the venter, is one, or possibly two setæ, on each side.

The following families may be found in searching for corn borers:

a Prolegs may be represented by swellings but hooks are never present; thoracic legs may or may not be present; setal arrangement never as in Fig. 11, no. 13. *Prodoxidæ*

aa Prolegs, or at least crochets, nearly always present, if not, setal arrangement as in Fig. 11, no. 13. (See Gelechiidæ.)

b A group of three setæ in front of the thoracic spiracle.

c Prolegs with one complete circle of large hooks and numerous irregular rows of very small ones (Fig. 11, no. 2) .... *Acrolophidæ*

cc Prolegs never with the small hooks as in Fig. 11, no. 2 and never with more than three rows.

d Hooks of prolegs arranged in two bands, one on each side of the proleg (Fig. 11, no. 6) .... *Ægeriidæ*

dd Hooks of prolegs arranged in a complete circle (sometimes absent in Gelechiidæ).

e Of the four setæ nearest the median line on the dorsum of the ninth abdominal segment, the caudal two (setæ II) are closer together than on any other segment (Fig. 11, nos. 9, 10); body usually not tapering at the caudal end nor sharply constricted between segments .... *Tortricidæ*

ee The four setæ on the dorsum not varying greatly in arrangement on the ninth abdominal segment; body usually tapering at the caudal end and often strongly constricted between segments { *Gelechiidæ* / *Œcophoridæ* }

bb With two setæ in front of, or occasionally slightly below, the thoracic spiracle; one of the setæ often very weak or small so that it is not easily located.

c Hooks of prolegs arranged in a complete circle or one nearly complete (Fig. 12, nos. 16, 17, 25), never with a single row on the mesal margin . . *Pyralidæ*

cc Hooks of prolegs in a single row or band along the mesal margin (Fig. 14, nos. 37, 42) .... *Noctuidæ*

Prodoxidæ.—The larvæ of this family are found only in Yuccas and are only likely to be confused with those Gelechiidæ which lack prolegs. The setal and ocellar arrangement should be enough to distinguish them and no gelechiid borer has been described from Yucca.

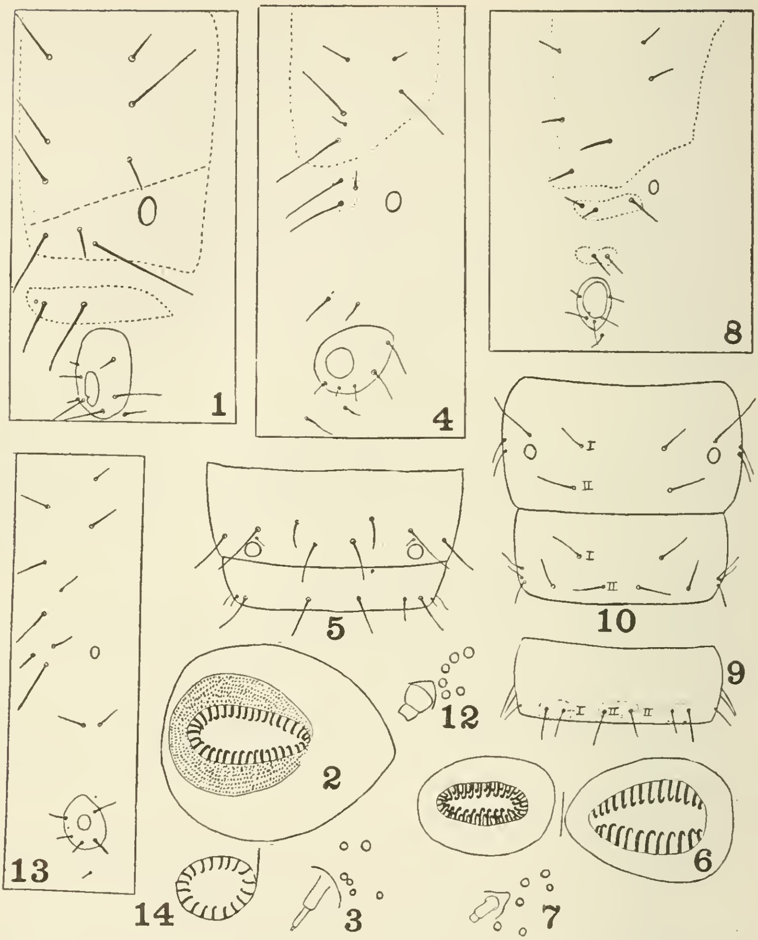

Fig. 11. 1, Acrolophidæ, *Acrolophus mortipennellus*, setal map of prothorax; 2, proleg of same; 3, ocellar arrangement; 4, Aegeriidæ, *Melittia satyriniformis*, setal map of prothorax; 5, eighth and ninth abdominal segments; 6, proleg; 7, ocellar arrangement; 8, Tortricidæ, *Eucosma* sp.?, setal map of prothorax; 9, ninth abdominal segment; 10, *Cacœcia* sp., eighth and ninth abdominal segments; 11, proleg; 12, ocellar arrangement; 13, Gelechiidæ, *Metzneria lappella*, setal map of prothorax; 14, proleg of unnamed species.

Acrolophidæ.—These are not true borers but have been taken in the bases of corn stalks while searching for Crambids. These larvæ are often picked up in fields in the fall while they are searching for a place to hibernate. Of the three species listed in the twenty-third Illinois report, one is much more common than the others, *Acrolophus arcanellus* (*Pseudanaphora arcanella*) (Fig. 11, nos. 1–3). The prothoracic

shield is very heavily chitinized on all these species and extends ventrad to include the spiracular group of setæ. The ocellar arrangement is also distinctive.

Aegeriidæ.—The only species of this family to be included here is *Melittia satyriniformis*, the squash-vine borer. The arrangement of hooks on the prolegs is distinctive (Fig. 11, no. 6) but figures of the prothorax, ocellar group and eight and ninth abdominal segments (Fig. 11, nos. 4, 5, 7) are given as a contrast to the Tortricidæ, to which this family is closely related.

Tortricidæ.—Several species of this family have been reported from various seeds and seed pods. The commonest genus found boring in stems is *Eucosma*, some members of which form galls. I have several species of this family which are as yet unidentified and figures of one of these from ragweed, which may be a species of *Eucosma*, are given. These (Fig. 11, nos. 8, 9) show the characteristic tortricid arrangement of setæ on the prothorax, also on the ninth abdominal segment. Another type of arrangement of the setæ on the ninth segment is shown in Fig. 11, no. 10. The ocellar arrangement (Fig. 11, no. 12) has been fairly constant in the species studied. The hooks on the prolegs are usually of two sizes but Fracker (Illinois Biological Monographs, Vol. 2, No. 1) states that in some Tortricids they are all of one size.

Gelechiidæ.—The majority of the larvæ of this family which live in plant stems form galls, and may be identified by Dr. Felt's excellent paper (N. Y. S. M. Bul. 200). The potato tuber moth, *Phthorimaea operculella*, is one which does not form galls, and an unidentified species of this genus has been taken many times in stems of giant ragweed and Silphium. *Metzneria lapella*, found in the fruits of burdock, and *Sitotroga cerealella*, the Angoumois grain moth, illustrate the type of gelechiid in which the prolegs are absent. The arrangement of setæ (Fig. 11, no. 13) will distinguish these larvæ from all others with the hooks of the prolegs arranged in a circle. Most of the boring species examined had hooks of one size (Fig. 11, no. 14) but many species in the family have them like the tortricids (Fig. 11, no. 11).

Œcophoridæ.—The commonest member of this family is the parsnip webworm, *Depressaria heracliana*, which, after feeding in the flower heads and among the seeds of various Umbelliferæ, and causing a characteristic webbing of the umbel, bores down into the stalk and pupates. The larvæ are true gelechiids, and were at one time included with them. Fracker remarks that "no satisfactory character has been found to separate them" and uses the arrangement of the ocelli which he finds unsatisfactory. The setal arrangement of *D. heracliana* is like that of the gelechiids (Fig. 11, no. 13) but it has proleg hooks of three sizes. It is yellow with black spots around the setæ, and the

abdominal segments show clear spaces much like *Pyrausta penitalis* (Fig. 13, no. 28, *b*).

Pyralidæ.—This family contains many injurious pests and among them several well-known borers. The larvæ are distinguished by the two setæ in front of the prothoracic spiracle, or slightly below it (Fig. 12, nos. 15, 18, 24) and the arrangement of hooks on the prolegs (Fig. 12, nos. 16, 21, 25) which are nearly always of three sizes, arranged in a complete circle, or in a broken circle, open at the lateral margin. In three of the subfamilies, Phycitinæ, Crambinæ and Pyraustinæ, are species with the boring habit. There is considerable individual variation in nearly all the species of this family making the classification exceedingly difficult. It will be impossible to make anything like a good classification, until a larger number of species have been reared. The following key will separate the principal genera.

a Hooks of prolegs arranged in a complete circle and of three sizes (Fig. 12, no. 16)
- *b* Adfrontal pieces reaching the vertical triangle (see Fig. 13, no. 29) which is very large; eight setæ present on each half of the ninth abdominal segment and not arranged in a straight line . . . . *Elasmopalpus*
- *bb* Adfrontal pieces not reaching the vertical triangle, which is of normal size; six setæ present on each half of the ninth abdominal segment, arranged in a straight line.
  - *c* Spiracular setæ always below the level of the thoracic spiracle (Fig. 12, no. 18); body never with skin sculpturing, as in Fig. 13, nos. 33, 34, but smooth, nor with a chitinized spot caudad of the spiracle on each proleg-bearing segment (see Fig. 13, no. 28, *s. p.*) body always with prominent black or brown spots around the setæ . . . . *Diatræa*
  - *cc* Spiracular setæ seldom below the level of the thoracic spiracle (Fig. 12, no. 15), usually at least one of them in front of it, if both are below the level of the spiracle then there is a very distinct chitinized mark caudad of the spiracle on each proleg-bearing segment; skin often with sculpturing as in Fig. 14, no. 33 . . . . *Crambus*

aa Hooks of prolegs not arranged in a complete circle (Fig. 13, nos. 21, 25)
- *b* Setæ of prothorax and ocelli arranged as Fig. 13, nos. 20, 22; thorax distinctly narrowed towards the head, which is comparatively small . . . . *Diaphania*
- *bb* Setæ of prothorax and ocelli arranged as in Fig. 12, nos. 24, 26; thoracic segments of approximately the same width; head of normal size . . . . *Pyrausta*

Phycitinæ.—The only member of this family likely to be met is *Elasmopalpus lignosellus*, the lesser cornstalk-borer. It is easily distinguished by the character given in the key, also by the peculiar striped and banded appearance. One of the setæ on the lateral surface of the ninth abdominal segment is small and weak and should not be overlooked. *Etiella zinckenella*, reported as boring in beans in the west, belongs here, but is comparatively rare. Another borer in the stems of beans, *Monoptilota nubilella*, forms galls, and is not considered here.

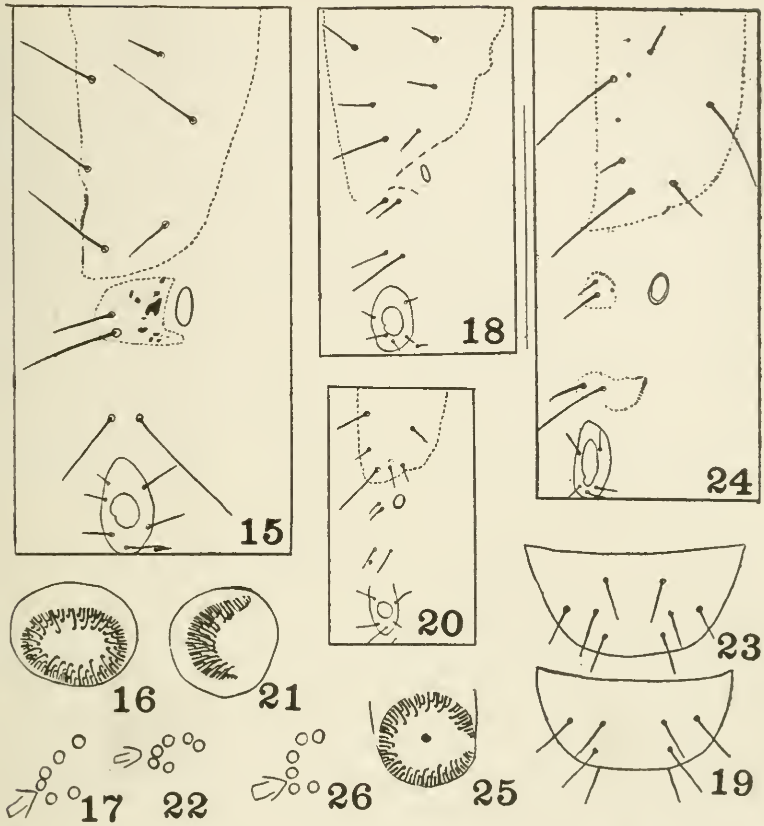

Fig. 12. 15, Pyralidæ, *Crambus* sp., setal map of prothorax; 16, proleg; 17, ocellar arrangement; 18, *Diatræa zeacolella*, setal map of prothorax; 19, tenth abdominal segment; 20, *Diaphania nitidalis*, setal map of prothorax; 21, proleg; 22, ocellar arrangement; 23, tenth abdominal segment; 24, *Pyrausta nubilalis*, setal map of prothorax; 25, proleg; 26, ocellar arrangement.

Crambinæ.—Many members of this subfamily resemble certain Pyraustinæ in many characters. The ocellar arrangement (Fig. 12, no. 26) and that of the setæ on the tenth abdominal segment (Fig. 12, no. 19) seem to be very constant characters, as well as those given in the key. Fracker states that some Crambids have the proleg hooks arranged in a broken circle like *Pyrausta* (Fig. 12, no. 25) but of two sizes instead of three. None of these have been found among the species under observation. In this subfamily the genus Crambus has a few species which are borers, and the genus Diatræa has two, the larger cornstalk-borer, *D. zeacolella*, and the sugar-cane moth borer *D. saccharalis cramboides*. Out of the large genus *Crambus* only four named species, *vulgivagellus*, *trisectus*, *leachellus*, and *hortuellus*,

were available and a considerable number of unnamed species. Each of these species could easily be separated from either of the species of *Diatræa* but genus characters are hard to find, owing to the great differences between some of the species, which seemed greater than those between certain of the species and *Diatræa*. In addition to the characters given in the key, there are certain cuticular markings, which may indicate sensory pores, that are always found in Crambus and never in Diatræa. On the chitinized area in front of the thoracic spiracle bearing the setæ, all Crambus species have certain markings, sometimes dark as in Fig. 12, no. 15, or at other times light, and somewhat transparent in appearance. Nearly all the species examined had the darkly chitinized spot caudad of the spiracle on the proleg-bearing segments much as those in Pyrausta (Fig. 13, nos. 27, 28, *s. p.*). On these same segments, and sometimes on others, a small circular or oval area was always found mesad of setæ I. Similar markings are also found in Pyrausta (Fig. 13, nos. 27, 28), but always dark-colored; while those in Crambus are generally pale.

Pyraustinæ.—In addition to the characters given in the key this subfamily may be distinguished by the arrangement of setæ on the tenth abdominal segment (Fig. 12, no. 23), and the different arrangement of the ocelli (Fig. 12, no. 22, 26). Specimens of the genus *Phlyctænia*, which sometimes bores into stalks of celery, have not yet come to hand, so this genus is reluctantly omitted. *Diaphania nitidalis*, the pickle worm, and other species of the genus may easily be separated by means of the key and Fig. 12, nos. 20–22. Out of six species of Pyrausta examined, four of them namely—*nubilalis*, *penitalis*, *illibalis* and *futilalis*—only two seem very closely related, *P. nubilalis*, the European corn borer, and *P. penitalis*, a borer in Polygonum and other weeds. Specimens from the Illinois State Natural History Survey labeled *P. nelumbialis*, now a synonym for *penitalis*, do not resemble other material of this species. They are considerably larger, fully one-third longer, with much finer skin sculpturing, the spiracles more than twice as large, and no trace of certain minute setæ found on both *penitalis* and *nubilalis*. This species varied from other species studied by the characteristic skin sculpturing shown in Fig. 13, nos. 33 and 34. This is considerably coarser in *penitalis*. The two species, *penitalis* and *nubilalis*, are so closely related that they are very difficult to separate. Since *penitalis* occurs in the region infested by the corn borer, and also infests corn, it is important to be able to separate them.

One of the easiest characters is the chitinized shield of the tenth abdominal segment, which is usually truncate along the anterior margin in *penitalis*, as in Fig. 13, no. 32, and with a rounded projection at the cephalo-lateral angle but this character is not reliable, since many

individuals show it with an emargination as in *nubilalis* (Fig. 13, no. 31) and less often with the sharper cephalo-lateral angle usually found in that species. The anterior dorsal setæ (setæ I) on the eight abdominal segments are, like most of the setæ, situated on dark tubercles which are often almost contiguous in *penitalis*, separated by a distance usually much less than the width of the tubercle, while the distance is usually much greater in *nubilalis*, but these vary somewhat. Another useful character, if its variations could be well described are the clear areas of the abdominal segments. These are shown contrasted in Fig. 13, nos. 27 and 28 and again in Fig. 13, nos. 31 and 32. These are always very distinct on each side of the median line on abdominal segments 2–8 in *penitalis*, each space oval, and nearly every space well bounded and separated from the next one, so as to give a row of them a distinctly moniliform appearance. Segments 3–7 usually show these rows of spaces divided into two sections, near the middle of the row, the space between varying in different segments (Fig. 13, no. 28). While these spaces may vary slightly as to number or degree of separation between individual spaces, there is a remarkable uniformity in all the segments. This is never true in *nubilalis*. After studying a large series of specimens, nothing approaching the regularity of *penitalis* was discovered. This species seldom shows anything but an irregular clear strip, but occasionally the spaces on one or two segments will seem to be quite distinct, but this arrangement will be different on other segments. The arrangement of spaces in *nubilalis* is shown in Fig. 13, no. 27 and they are seldom more distinct. When a skin is cleared and mounted the clear spaces in *penitalis* remain unchanged, while the nearest approach to this arrangement in *nubilalis* showed only a clear band, with no subdivision into individual spaces. There is a prominent furrow caudad of the anterior tubercles in *penitalis*, ending at the sensory pore. In *nubilalis* there are many more clear spaces in this location.

The setal arrangement on the head varies in the two species. The anterior setæ and punctures (*ant. 1, 2 ant. P*) have a very constant arrangement. In *penitalis* (Fig. 13, no. 30) they are not in line, the second seta being farther laterad than the first seta and the puncture. In *nubilalis* the setæ and puncture are nearly in line, with the puncture a little laterad. The adfrontal setæ and punctures offer some help in determination, their position in *penitalis* being fairly constant, with the second adfrontal always below seta *P* (Fig. 13, no. 30). The setæ in *nubilalis* are more variable in their arrangement, being sometimes much like *penitalis* with the second adfrontal opposite seta *P*, rarely below it. In many individuals they are as far dorsad as in Fig. 13, no. 29 which represents the extreme in that direction.

The skin sculpturing is of some help, being apparently very constant

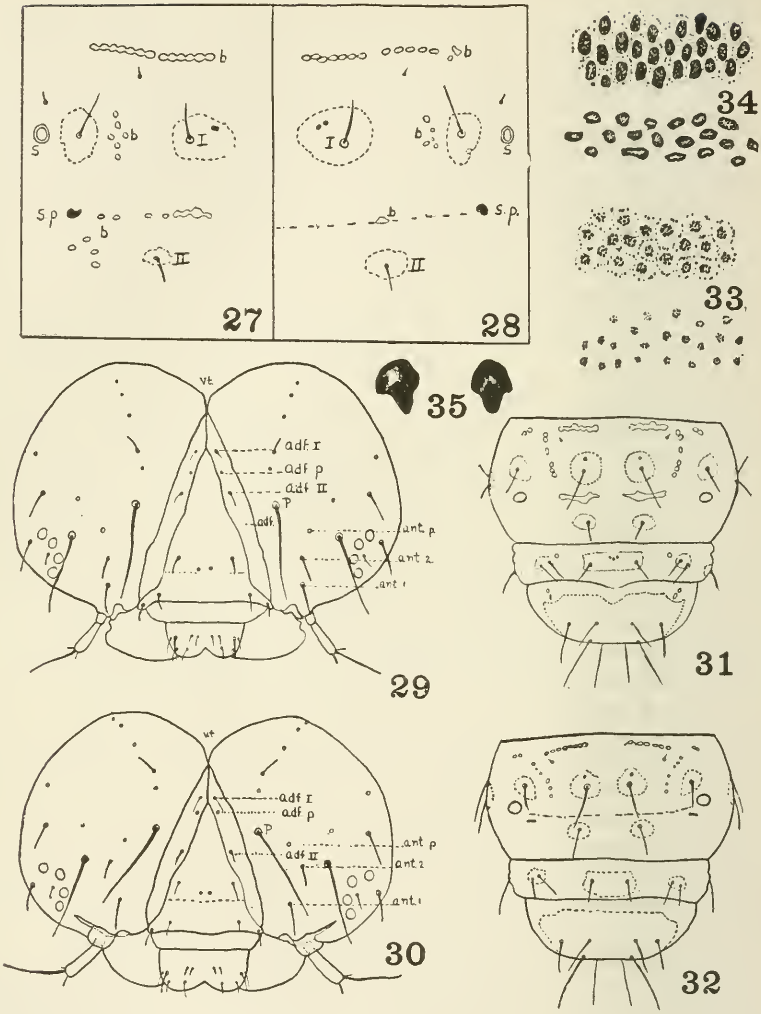

Fig. 13. Comparison of structures, *Pyrausta nubilalis* and *P. penitalis.* 27, *P. nubilalis,* left side, dorsum fourth abdominal segment, *I,* seta I; *II* seta II; *b,* clear spaces; *s,* spiracle; *s. p.,* sensory pore?; 28, same segment, *P. penitalis;* 29, *P. nubilalis,* cephalic aspect of head, *adf.* adfrontal area; *adf. I, adf. II,* adfrontal setæ; *adf. p.* adfrontal puncture; *P,* large seta of epicranium; *ant. 1, ant. 2,* anterior setæ; *ant. p.,* anterior puncture; *v. t.,* vertical triangle; 30, *P. penitalis,* cephalic aspect of head; 31, *P. nubilalis,* abdominal segments, 8–10; 32, *P. penitalis,* same segments; 33, *P. nubilalis,* skin sculpturing, upper half from between setæ of dorsum, fourth abdominal segment; lower, from below spiracle; 34, *P. penitalis,* skin sculpturing from same locations; 35, sensory pores? enlarged.

in *penitalis* as shown in Fig. 13, no. 34. In a very few instances the arrangement in *nubilalis* was found to approach that of *penitalis*, but the majority of cases showed the sculpturing as in Fig. 13, no. 32.

The sensory pores (Fig. 13, no. 35 *s. p.*) are usually more elongate in *nubilalis*, but vary in the two species.

The remaining species either had conspicuous black or brown spots around the bases of the setæ, as in *P. futilalis* and *P. illibalis*, or very pale yellowish ones. None of these had the chitinized marks (sensory pores) caudad of the spiracles on the proleg-bearing segments as in the previous group. *P. futilalis* has very large hooks on the prolegs and these extend around about two-thirds of the circumference. The labrum is more deeply notched than any of the others and the spiracles are decidedly oblong, edged with a prominent black chitinous ring. The full-grown larvæ average 25 mm. in length. *P. illibalis* is distinguished by the very small prolegs often with black tips. These bear very much smaller hooks than any of the others and when these are retracted the end of the proleg outside the hooks is seen to be covered with minute spines. The labrum is notched like *futilalis* but edged with a band of black. The spiracles are nearly circular with a narrow pale brown ring. The average length of a mature larva is 20 mm.

Noctuidæ.—There are quite a number of noctuid borers and all easily recognized by the characters given in the key. Several species of this family, such as *Arzama obliqua* and *Nonagria oblonga*, which normally bore in the stalks of the cat-tail, have been reported from corn. Other noctuid borers are the iris borer, *Macronoctua onusta*, certain species of Hadena reported from corn, *Chloridea virescens* which attacks tobacco, etc. Of all the species of noctuid borers, there were only available, *Papaipema nitela*, the common stalk borer, *P. furcata*, *P. nebris*, and *P. cataphracta*, *Heliothis obsoleta*, the corn ear worm and *Achatodes zeæ*, the spindle worm. These genera may be easily separated by the figures given of each. The stripes on *P. nitela*, the commonest borer, are not always very distinct, especially in the younger stages. The sixth seta on the shield (Fig. 14, no. 43 *a*) and the second spiracular (Fig. 14, no. 43 *b*) are usually very weak or wanting. This genus has been carefully studied by Mr. Henry Bird who has written descriptions of many species of larvæ. *H. obsoleta* often bores in stalks and the young stages look considerably like the European corn borer, and has been found in stalks infested by them. The skin sculpturing (Fig. 14, no. 39) is distinctive, no matter what the coloration. It consists of large spiny cuticular appendages, with alternating small spines, while minute ones fill up the spaces. *Achatodes zeæ* is always white with small black spots around the setæ, and the most easily recognized of all the noctuid borers. It is found in a variety of plants

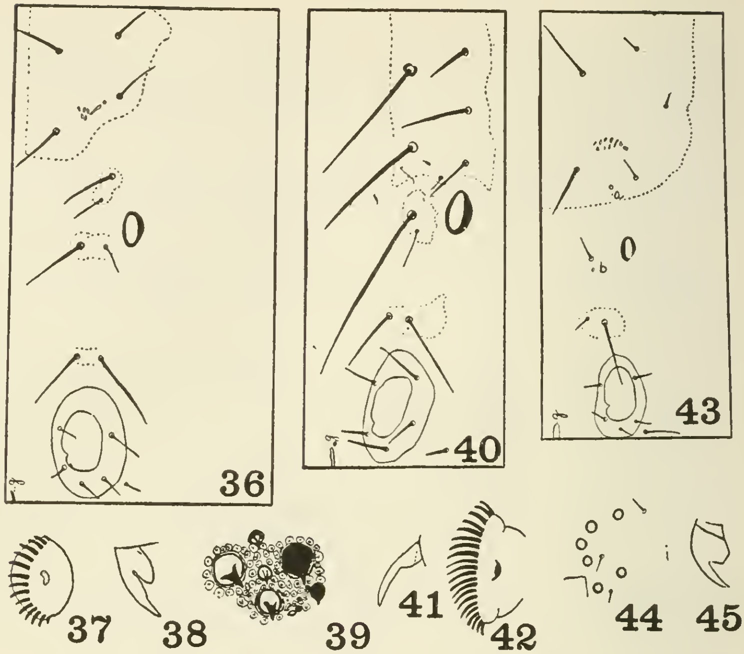

Fig. 14. 36, Noctuidæ, *Heliothis obsoleta*, setal map of prothorax; 37, proleg; 38, tarsal claw; 39, skin sculpture; 40, *Achatodes zeæ*, setal map of prothorax; 41, tarsal claw; 42, proleg; 43, *Papaipema nitela*, setal map of prothorax; 44, ocellar arrangement, typical of Noctuidæ; 45, tarsal claw.

and when mature averages 35 mm. The prothoracic gland is found in all of these noctuids, the slit where it is everted is represented in Fig. 14, nos. 36, 40, 43 *g*.

I am greatly indebted to the following persons for loans and gifts of material and some of them have given valuable suggestions: Dr. E. P. Felt, Dr. W. E. Britton, Dr. Edith M. Patch, Dr. H. Garman, Mr. D. J. Caffrey, Mr. George G. Ainslie, Mr. C. P. Alexander, Mr. Henry Bird, Mr. Philip Luginbill and Mr. T. H. Parks.

Scientific Notes

Notes on Some Insect Pests of Costa Rica. During the latter part of February and March of this year, while in Costa Rica for a vacation, a few observations were made of the insect pests of that country. As the most serious of the pests do not as yet occur in the United States, a few notes on them will be of more than casual interest.

The most important "find" was, no doubt, the "mosca prieta" or spiny citrus whitefly (*Aleurocanthus woglumi* Ashby). It was very abundant on citrus of various species at Limon and at all the stations of the Northern Railroad as far as Peralta. At Cartago, at an elevation about one mile, it was not found. The degree of infestation was worse than it is in the Canal Zone. The trees were so heavily infested as to be readily noticeable from the car windows. This whitefly occurs probably all through Central America and tropical South America, particularly along the Atlantic seaboard. From questions asked of the customs and port authorities, and from actual observations, it would appear that this insect gained access to Costa Rica from small sailing vessels coming from San Andres and other islands of the Caribbean. It seems to be an inborn custom of the islanders to carry potted plants wherever they go. Thus far fifty-two hosts, representing twenty-six families of plants, have been recorded for *A. woglumi*, among them being the various species of citrus, mango, star-apple, cashew apple (marañon), papaya, chirimoya, mamei, plantain, and coffee.

The purple scale, *Lepidosaphes beckii* Newm., and sooty mould were extremely abundant on both leaves and fruit of citrus.

Another bad pest was the Hawaiian sugar-cane borer, *Rhabdocnemis obscurus* Bois. It was exceedingly abundant at Zent, C. R., in banana stumps and cuttings. As many as forty adults were taken out of a small piece of stalk about a foot long. Dr. W. D. Pierce, in his Manual of Dangerous Insects, cites the following hosts for this weevil: banana, sugar-cane, cocoanut, sago palm, royal palm, wine palm, and papyrus. The important observation here was a few adults were found crawling on the leaves of banana, showing that this serious pest can very easily be introduced into the United States among the banana leaves used as packing for fruit on boats calling at New Orleans.

At Limon, and awaiting boats for shipment to the United States, were about a hundred flat cars loaded with Balsa logs, and, from data obtained, these were here from one to four weeks. Under the bark of these logs were found a number of lepidopterous larvæ and pupæ. The great majority of the logs were infested with several species of borers, specimens of which have been sent to the Bureau of Entomology for identification. These borers were very active and abundant. As the determinations are lacking at present writing, it is impossible to say whether they are already present in the United States. However, the degree of infestation and the ease with which such logs can enter the United States, makes the introduction of such pests a certainty, and it is time to pay attention to the possibilities of this source of danger. Otherwise many new and dangerous pests will unquestionably be added to our already large list of insect-immigrants.

James Zetek, *Ancon, Canal Zone.*

A Source of Confusion in the Diagnosis of Nosema apis in Adult Bees. In March, 1917, the writer received for diagnosis from Cabarrus County, North Carolina (Samples Nos. 5324 and 5325), a sample of dead bees and two brood frames containing honey, pollen and a few dead bees with heads in cells. These frames were from the colony from which the dead bees had been taken, the colony having shown marked symptoms of dysentery earlier in the season with many bees dying. Microscopic examination of the large intestines from several of the dead bees macerated in salt

solution showed large numbers of highly refractile oval bodies strongly resembling the spores of *Nosema apis*, the microsporidian parasite sometimes associated with adult diseases of bees.

To determine whether any of these spore-like bodies might be present in the honey of the colony from which the dead bees were taken, several square inches of comb, containing sealed cells of honey but no apparent pollen cells, were cut from the frames and the honey was squeezed therefrom through cheesecloth. This honey was a clear dark amber color having a peculiar somewhat bitter flavor and a disagreeable odor. On standing a yellow scum came to the surface, containing a large amount of pollen.

Several grams of this honey were dissolved in about 30 cc. of distilled water and centrifuged. Microscopic examination of the residue under a cover glass in a water mount and with the high power dry lens, showed what was apparently a large number of *Nosema apis* spores and also many unidentified pollen grains of various shapes, large round ones predominating however. After accidentally crushing some of these pollen grains under the cover glass it was found that several of the large round fairly smooth grains seemed to be packed full to overflowing with these refractile spore-like bodies. Also the microscopic field had become crowded with countless numbers of these bodies.

A second lot of honey was treated in the same manner, only this time the residue was washed several times with salt solution. Microscopic examination showed the same appearance particularly after crushing with the cover glass.

Next, pollen from cells in the comb from which the honey had been taken was examined in a water mount in the same manner. These same spore-like bodies were found to be present only in much smaller numbers until the pollen grains were crushed as before when the spore-like bodies again appeared in large numbers.

Pollen grains from combs taken at random from several different sources were then examined but no such appearance was found in any of the samples examined.

Stained smears from the intestinal contents of the dead bees and also from the residue after centrifuging the diluted honey gave no results as these bodies seemed to have disappeared or been destroyed during the process of staining. Finally, some Gram's iodine solution was run in under the cover glass of a water mount of some of this material. Almost immediately these spore-like bodies turned a deep purple color and the pollen grains containing them turned almost black giving what appeared to be a typical starch reaction. It was then found, aided by the kindness of the pollen laboratory of the H. K. Mulford Company of Glen Olden, Pa., that these pollen grains were from corn and that although this is the most striking example of the presence of starch granules in pollen grains, most of the cereal grains show the same condition, but they are not found in pollen of other families.

These starch grains upon measurement and comparison with the size and appearance of the actual *Nosema apis* spores were found to have just about the same measurements and shape although the shape of starch grains was a little more variable, often being more nearly round than the typical long oval.

Furthermore, it has been found experimentally that such materials as starch and dextrin are indigestible to bees, causing what might be called acute indigestion or auto-intoxication. Therefore, the presence of so much indigestible starch in the pollen food of the bees was probably a contributory factor if not the actual cause of the dysentery and death of so many of the adult bees in this particular instance cited.

Starch granules have since been found in a few samples received for examination. Therefore, it has since then been the custom after making a preliminary microscopic examination, to treat with iodine solution in the above manner all material from samples sent in for diagnosis of adult diseases, in order to prevent possible future confusion. This precaution should be taken in all such examinations.

Arnold P. Sturtevant, *Bureau of Entomology.*

A Note on Temperature in Relation to ***Sciara coprophila*** **Lintner.** In the winter of 1918 an outbreak of *Sciara coprophila* Lintner interfered with an experiment in which Dr. W. H. Burkholder of the Department of Plant Pathology of Cornell University was testing the growth of beans at three constant temperatures. The experiment was carried on in three parts, one at a temperature of 91° F., another at 76° F. and a third at 60 to 65° F. The moisture content of the pots was kept uniform by the use of Livingston auto irrigation. The beans grown in soil at a temperature of 91° were uninjured, but those growing in earth at 76° were seriously damaged while some at the lower temperatures of 60° to 65° were slightly attacked. The air temperature of the greenhouse varied between 70° and 80° F.

To regulate the evaporation, the pots in which the beans were planted were covered with paraffine paper and a paper cylinder was placed around the plant to prevent the paraffine coming in contact with the stem. Adults of Sciara were found entering these cylinders and laying eggs in the moist earth to which manure had been added as a fertilizer; later when the paraffine covers were removed, large numbers of flies were liberated; eggs, larvæ and pupæ also were found commonly present in the soil of the pots. The beans were in a weakened condition, many of the lateral roots having been eaten off and the taproot itself attacked.

Although these data were obtained by chance, they tend to indicate that the optimum soil temperature favorable to the reproduction of the fly is near 76° F. and below 91° F. Evidently infestation may take place in soil that has a temperature of 60 to 65° F., but apparently this is not the most favorable temperature for the continued and abundant increase of the insect.

I. M. Hawley,
Department of Entomology, Cornell University.

Handbook or Compendium. An entomologist's handbook or compendium is very much needed, especially by economic entomologists. It is planned to compile such a handbook, which will include principles and methods of studying the life-histories of insects, of conducting field experiments and demonstrations, handy tables for field workers, etc. It is desired to have references, or better, to have separates of all published notes dealing directly or indirectly with the subject and to have details, and if possible drawings or photographs as well, of cages, apparatus, methods, etc., as yet unpublished. The handbook will be a compilation and full credit given to all contributions.

The coöperation of entomologists is solicited.

John J. Davis, *Box 95, West La Fayette, Indiana.*

Commercial Entomology. A recent manual of spraying, issued by a company which prepares spray materials and which is illustrated by colored plates, gives a figure on the plate of the San José Scale labeled "egg of female" and another labeled "egg of male"!

This is a contribution not only to entomology but indeed to natural history as a whole. It is to be hoped that some parts of this manual, at least, are more reliable than this.

H. T. F.

Lachnosterna crassissima (Blanch). Three adults of this species were in the stomach of a channel catfish (*Ichtalurus punctatus*) caught in a small stream in southern Kansas, July 6, 1918. In the stomach of second fish was a handful of wheat grains. Two adult *L. fusca* (Froelich) were in the stomach of a crappie (*Pomoxis annularis*) caught in June, 1911, in the same small stream.

E. G. Kelly,
Extension Entomologist, Kansas State Agricultural College.

A New Monophlebine Coccid from Borneo. Many years ago Westwood described a male Monophlebid from the Gulf Coast, West Africa, remarkable for the red costal region of the wings. In 1915 Prof. C. F. Baker sent me an insect of this type from the island of Palawan, in the Philippines. I now have before me a third species, also from Professor Baker, represented by two specimens from Sandakan, Borneo (Baker 9615). It may be described as follows:

Llaveia hæmatoptera n. sp.

Male similar in nearly all respects to *L. sanguinea*, from Palawan, but differing thus: (Larger, wings 8 mm. long, expanse 18 mm.; head and thorax warm reddish, without black or piceous; eyes bright red, not dark; the six fleshy processes of abdomen very long, the last about 3.5 mm.

The three species are readily separable as follows:

Thorax red; larger species .... *hæmatoptera* Ckll
Thorax at least mainly black or piceous above; smaller species 1
1. Caudal tassels not half width of abdomen .... *raddoni* (Westwood)
Caudal tassels much over half width of abdomen .... *sanguinea* Ckll.

T. D. A. Cockerell,
University of Colorado.

The San José Scale in the Argentine Republic. Mr. Juan Bréthes of Buenos Aires sends me a Coccid, remarking that it is certainly new to the Argentine Republic, but doubtless known from elsewhere. It is indeed, for it is *Aspidiotus perniciosus* Comstock. I have written urging that measures to taken to eradicate it, if it is not too late.
T. D. A. Cockerell.

Army worm. (*Heliophila unipuncta* Haw.) The search this spring for European corn borer larvæ, *Pyrausta nubilalis* Hubn., in portions of New York state, resulted in finding in cornstalks in early April partly grown army worm caterpillars. They were then nearly three fourths of an inch long and although more highly colored and usually rather distinctly striped, presented a somewhat general resemblance to the true corn borer. These caterpillars were found in soft or punky corn stalks, evidently having entered simply for shelter. They were so numerous in sections about Ballston that seven or eight of these larvæ were frequently found to one or two of the true corn borer. It was this insect and not the corn borer which was found at Schuylerville, Saratoga County. The identity of these young army worm larvæ was not fully established until early in May at which time more characteristically colored, half grown caterpillars were found in similar situations.

The above record in relation to army worms is entirely new for New York state and is of particular interest in view of the statements published by Mr. Vickery[1] relative to the tropical or subtropical origin of this species and his belief that it was problematical if it would survive a mild winter as far north on the Atlantic coast as the city of Washington. It is true that the past winter has been exceptionally mild and this may be the reason why the species lived through in the vicinity of Saratoga, though it should be remembered that corn fields in New York state have never been examined so carefully as during the past few months and this latter may be the real reason why the larvæ were found. It is certain that the army worm occurs annually here and there in the state and this fact, taken in connection with its known survival of the winter of 1918–1919, leads us to believe that it may withstand the rigors of our climate more successfully than is suggested in the above cited article.

E. P. Felt.

[1] Journal Economic Entomology, 8:390, 1915.

Anthrenus verbasci Linn., a Seventeen-Year Breeding Record. April 4, 1902, two ears of popcorn, infested by this insect, were received and placed in a two quart Mason jar and the latter kept tightly closed with no moisture aside from that in the somewhat dried corn. Breeding has continued apparently uninterrupted for seventeen years, namely to April 4, 1919, at which time a living larva was found and there are presumably others alive, either adults or larvæ, though June 26, 1918, rather close search failed to disclose anything living. In the spring of 1909 (Journ. Econ. Ent., 2: 193) the bottom of the jar was nearly covered with fine, white, globose particles, apparently starch grains, fallen from the eaten kernels of corn and there was a thick mass of brown larval skins and other débris. Conditions were practically the same in the spring of 1912 (Journ. Econ. Ent., 5: 297) except that there was more débris. There then remained much uneaten corn and the same is true at the present date, April 4, 1919, except that breeding appears to be reduced to a minimum, though not from any scarcity of food. There would seem to be no reason why breeding may not continue under these conditions for a considerable series of years, unless the strain has become depleted through continued inbreeding.

Those interested in the ability of Dermestidæ to adapt themselves to untoward conditions are referred to the very interesting account by J. E. Wodsedalek (*Science*, 46: 366–67, '17) in which he records the curious results following five years of starvation of larvæ of *Trogoderma tarsale*, which resulted in a gradual decrease in the size of the larvæ, the size shrinking, even to the hatching length, and increasing with the scarcity and abundance of food respectively.

E. P. Felt.

Regarding Personal Credits in Farmers Bulletins of the U. S. Bureau of Entomology. Until early in 1916 the custom of publishing personal credits was uniformly observed in the Farmers Bulletins issued by the Bureau of Entomology of the United States Department of Agriculture. About that time, however, a change in departmental policy occurred respecting such matters, and the custom was discontinued. The object in view in making this change was to render the included matter more acceptable to the class of readers for whom it was intended. It was held that such persons have no interest in the personnel of the originating organization back of such publications, and that the inclusion of personal credits tended to detract from the brevity and directness of appeal of such publications.

That this view of the matter has much in its favor cannot be denied, but it is also true that the custom of omitting personal credits has sometimes given rise to adverse criticism, especially from persons who do not understand the attitude of the department in this matter. A case in point is the recent issue of Farmers Bulletin 1046 on the European corn borer under the authorship of Mr. D. J. Caffrey, who conducted the bureau's portion of the investigations of this recently discovered pest. A large portion of the biological investigations in connection with this work was performed by the late Mr. Stuart C. Vinal under the direction of the Massachusetts Agricultural College. Mr. Vinal was personally responsible for the original discovery of the insect, and conducted the preliminary investigations entirely alone, and it may even be said without exaggeration that he sacrificed his life for the success of the work by remaining at his post of duty for several days while suffering from the illness which caused his death.

L. O. H.

Turkeys and Chinch Bugs. Apropos to the recent discussion in this JOURNAL, on the enemies of the chinch bug (Flint, Oct., 1918, and McColloch, Feb., 1919), I wish to record an observation made at Edwardsville, Ill., June 10, 1917. Two to three weeks old turkeys, foraging in a wheat field near a farm house, became busily engaged eating the mature chinch bugs which were numerous in the wheat. The young turkeys searched eagerly for the bugs, ate them with apparent relish, and by many actual counts the individual bird picked them up at the rate of more than thirty a minute.

March 31, 1919. JOHN J. DAVIS.

IMPORTANT NOTICE

At the Baltimore meeting of this association it was voted that the price of the JOURNAL OF ECONOMIC ENTOMOLOGY should be fixed by the executive committee. Recognizing the large increase in cost in producing this publication, the committee has voted to increase the subscription price to all subscribers $1.00 per annum, beginning January 1, 1920. After that date, rates will be as follows:

Subscription price to members, $2.50 per annum.

An additional charge of 50 cents will be made to foreign members to cover cost of postage.

Subscription price to non-members, $3.50 per annum.

Subscription price to foreign subscribers, $4.00 per annum.

The annual dues of members of the association have not been increased and will remain as heretofore, namely:

Active members, $1.50. Associate members, $1.00 per annum.

A. F. BURGESS, *Secretary.*

Melrose Highlands, Mass.
May 23, 1919.

EUROPEAN CORN BORER CONFERENCE

Hon. Charles S. Wilson, New York State Commissioner of Agriculture, plans, as President of the Association of State Commissioners of Agriculture, calling a conference of Commissioners of Agriculture and Entomologists in particular to discuss and if possible formulate a National Policy in regard to this most serious pest. The conference will probably be held at Albany, N. Y., the last of August and will afford an unexampled opportunity to ascertain the latest facts in regard to the situation. It is very desirable for entomologists from all corn states to attend, because, in the ultimate analysis, they must have a very important part in determining this policy and the promotion of a sentiment in favor of a comprehensive and satisfactory program. E. P. FELT.

JOURNAL OF ECONOMIC ENTOMOLOGY

OFFICIAL ORGAN AMERICAN ASSOCIATION OF ECONOMIC ENTOMOLOGISTS

JUNE, 1919

The editors will thankfully receive news items and other matter likely to be of interest to subscribers. Papers will be published, so far as possible, in the order of reception. All extended contributions, at least, should be in the hands of the editor the first of the month preceding publication. Contributors are requested to supply electrotypes for the larger illustrations so far as possible. Photo-engravings may be obtained by authors at cost. The receipt of all papers will be acknowledged —Eds.

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Last winter entomologists of the northeastern United States found themselves confronted with a serious problem, namely the positive identification of a destructive Pyraustid caterpillar at a time when the comparatively harmless larvæ of allied species were practically unknown. Pyraustids have not occupied a conspicuous place as economic insects and have for the most part been left alone by economic entomologists. They have not proved particularly attractive to systematists. This is specially true of the larvæ. The conditions occurring last winter may easily be duplicated in other groups, though no one can indicate with any great degree of assurance the group of insects likely to be troublesome next. These facts suggest the need, and this is recognized by most entomologists, of a more symmetrical or general knowledge of the insect fauna as a whole. There are many earnest students engaged in solving problems and, unfortunately in some cases at least, there has been undesirable concentration upon a few groups at the expense of others which do not at the time appear so important or seem specially attractive. The present is an excellent time to consider this lack of method for the country as a whole and to see if some practical way cannot be found to overcome the difficulty. An intelligent distribution of effort would greatly lessen the probability of a recurrence of conditions such as obtained last winter. Would it not be possible for the specialists in various lines to suggest the groups requiring particular attention and when these are pointed out it might be feasible to work through our national organizations and secure a distribution of these problems to those willing to undertake such

studies, provided they were assured of reasonable time and freedom in which to complete the investigations. A little planning and coördination along such lines would do much, we believe, to produce a well rounded and comprehensive total of knowledge relating to American insects in all stages.

Reviews

Outlines of Economic Zoology, by A. M. Reese, pages I to XVII, 1 to 316, 194 illustrations. P. Blakiston's Son & Company, 1919.

The author correctly states that the study of insects is a large department of science in itself and owing to the difficulty of doing the subject adequate justice within the narrow limits of a small volume, he has confined himself largely to a discussion of a few disease-carrying insects, some of the more common household pests, the honey bee and the silk worm. The greater part of the book is devoted to very concise and interesting discussions of the economic relations of the other members of the animal kingdom and as such will prove of value to the entomologist who desires a recent summary of this character. (*Advt.*) E. P. F.

Canadian Bark Beetles, Part I, Descriptions of New Species, Part II, A Preliminary Classification, with an Account of the Habits and Means of Control, by J. M. Swaine, Dominion of Canada, Department of Agriculture, Entomological Branch, Bulletin 14, Part 1, pages 1 to 32, 1917, and Part II, pages 1 to 143, plates 31, 1918.

The first part of this important work is limited mostly to descriptions of new genera and new species and in the second part we have a comprehensive and most excellent classification of Canadian bark beetles, illustrated by a series of exceptionally fine figures showing not only structural details of many of the bark borers but also depicting characteristic workings of a number of species. This publication gives within a brief compass, an admirable summary of this important and very destructive group of beetles. The text and illustrations show the work of a man who has had both field and laboratory experience and is, therefore, in a position to discuss the subject matter in the most illuminating manner. (*Advt.*) E. P. F.

Studies on the Fruit Flies of Japan; Contribution I, Japanese Orange Fly, by Doctor Tsunekata Miyake. Reprint from Imperial Central Agricultural Experiment Station in Japan, Bul. II, No. 2, pages 85 to 165, plates 10, 1919.

This is a monographic study of the Japanese fruit fly, described as *Dacus tsuneonis*, the author giving a detailed discussion of both the external and internal structure of the adult, a similar study of the larva and numerous details in regard to the habits, life history and methods of controlling this species. Several associated or allied forms are also characterized. The author is to be congratulated upon the comprehensive character of his work and it is to be hoped that contribution I will be supplemented by other equally valuable studies. (*Advt.*) E. P. F.

Successful Spraying, by E. H. Favor, Hayes Pump and Planter Company, Galva, Ill., 127 pages. Price, $1.00.

It is not often that a spraying manual published by a company engaged in the manufacture of spraying machinery or insecticides is worthy of serious notice. This volume is an exception to the rule. Publications of this kind have a wide circulation and reach many who do not read the bulletins of the experiment stations (even where available). It is, therefore, gratifying to note that in the present instance sound and practical advice is presented in concise and attractive form. The text is clearly written and fairly well illustrated. In Chapter I the importance and value of spraying is clearly set forth and many practical suggestions are given as to methods. Chapter II deals with insecticides and fungicides, their preparation and uses. In Chapter III the common insect pests of orchard, vineyard, and garden are briefly described, the life history outlined and the proper treatment indicated. Chapter IV is devoted to plant diseases. Chapter V, "How to Spray," contains spraying schedules for various crops and directions for applying whitewash and disinfectants by means of the spray pump. In Chapter VI are many valuable suggestions as to use of the spray pump in disinfecting seed grain, in spraying hogs and cattle, in disinfecting poultry houses, and in killing weeds. Chapter VII is devoted to the spraying of citrus trees and the last chapter, also VII, treats of the spraying of shade trees.

The book has surprisingly few errors for a publication of this kind. "Black Leaf 40" tobacco extract does not contain 40 per cent nicotine sulfate as stated on page 28, but many official entomologists have fallen into the same error. (*Advt.*) C. R. C.

Current Notes

Conducted by the Associate Editor

Mr. Hugh Knight has been appointed assistant in entomology at the citrus substation, Riverside, Cal.

Prof. S. A. Forbes, state entomologist of Illinois, visited various points along the Atlantic Coast, the first week in May.

Lieut. R. V. Truitt of the Aviation Service is assistant in entomology and zoölogy at the Maryland State College of Agriculture.

Dr. J. M. Aldrich has been appointed honorary custodian of diptera in the United States National Museum in succession to the late Frederick Knab.

According to the "Review of Applied Entomology," Mr. G. F. Hill has been appointed entomologist of the Queensland Institute of Tropical Medicine, Townsville, North Queensland.

Dr. C. H. T. Townsend, specialist in the United States National Museum, Washington, D. C., has accepted a position in Brazil as official entomologist to the Sao Paulo State Government.

Mr. Charles H. Richardson, recently a research chemist with the Rohn and Haas Chemical Company, Bristol, Pa., has been appointed specialist in insect physiology, Bureau of Entomology, Washington, D. C.

Dr. W. A. Riley, of the University of Minnesota has been appointed a member of the joint committee of research of the Association of American Agricultural Colleges and Experiment Stations.

According to *Science* Lieut. A. C. Chandler, assistant professor of zoölogy at the Oregon Agricultural College, has been ordered to the front with the American soldiers to make a study of the rat parasites in France.

Dr. Robert Kirkland Nabours, professor of zoölogy and curator of the natural history museum at the Kansas Agricultural College, was recently elected president of the Kansas Academy of Science at its fifty-first annual meeting.

Prof. Franklin Sherman, Jr., and Mr. R. W. Leiby of the Division of Entomology, North Carolina Department of Agriculture, have both been sick with influenza followed by pneumonia. Both are now again on duty, though Professor Sherman has not yet fully recovered.

Mr. R. L. Webster, who holds an industrial fellowship at Cornell, is stationed at Geneva, N. Y., for the summer, working in coöperation with Prof. P. J. Parrott. During the winter Mr. Webster spent a month in Florida, studying the fumigation of citrus fruits in that state.

The following Bureau employees have returned from service in Army and Navy and have been reinstated in the Bureau: Lieut. W. H. Larrimer; Lieut. W. H. White; C. A. Weigel; Lieut. John A. Monteith, Jr.; Max W. Reeher; W. D. Whitcomb; F. L. McDonough; W. E. Dove; A. B. Jarrell; W. B. Cartwright; M. J. Kerr; R. B. Willson.

The Connecticut legislature has just adjourned after increasing biennial appropriations for entomological work as follows: for state entomologist, $15,000 from $12,000; for suppressing gipsy and brown-tail moths, $70,000 from $40,000; for inspecting apiaries, $4,000 from $1,500; for European corn borer, $10,000. A law has also been enacted requiring beekeepers to register with the town clerk in each town.

Mr. M. B. Dunn, temporary assistant at the Dominion Entomological Laboratory at Fredericton, N. B., has been appointed an entomological assistant in the Division of Forest Insects of the Entomological Branch, Ottawa, and, under the direction of Dr. J. M. Swaine, he will be assigned to sample plot investigations in the forests of Quebec and Ontario.

Mr. C. E. Pemberton, Bureau of Entomology, who followed Dr. Back in charge of the fruit-fly station and quarantine service in Hawaii, and who has been for the past year in war service in Honolulu, has been released from the Army and has accepted a position with the Hawaiian Sugar Planters' Association at a material financial betterment.

The following resignations in the Bureau of Entomology are announced: L. J. Hogg, cereal and forage insects, Arizona; Charles F. Stiles, apicultural extension work, Oklahoma; M. S. Linebaugh, L. P. O'Dowd, and E. A. McGregor, southern field crop insects; O. D. Link, truck crop insects, Florida; J. S. Stanford, cereal and forage crop insects; Q. S. Lowry, truck crop insect extension in Massachusetts; R. F. Wixson, special agent in apiculture for Virginia.

A conference on the subject of the gipsy and brown-tail moth quarantine was held May 6 at Washington. A. F. Burgess reported that this year there will be no need of an extension of the quarantine lines and in fact notable reductions can be made in some places. There was no necessity, therefore, for a public hearing.

Mr. J. M. Robinson, graduate of Ohio State University, became assistant entomologist at the Alabama Polytechnic Institute on January 1, 1919. Professor Robinson has charge directly of the class work in entomology and zoölogy. With the appointment of Professor Robinson, Dr. Frank L. Thomas became extension entomologist, and will devote at least half of his time to extension phases of entomological work in the state of Alabama.

Mr. D. C. Warren, formerly of the Alabama Polytechnic Institute, resigned January 1, 1919, to accept a position as assistant entomologist with the Georgia State Board of Entomology. Now Mr. Warren is located at Valdosta, Ga., and is expecting to conduct this year, especially, tests in the control of boll weevil by the use of calcium arsenate and other arsenicals. The tests will be conducted particularly with Sea Island cotton.

A coöperative investigation of the wireworms attacking cereal crops has been arranged between the Bureau of Entomology and the Washington State Agricultural Experiment Station. The Bureau has agreed to furnish a man who will be stationed in central Washington during the growing season of the year, to conduct the Bureau's portion of this coöperative work. F. R. Cole of the Forest Grove (Ore.) station has been assigned to this project for the present.

According to *Science* Maj. William B. Herms, associate professor of parasitology in the University of California, has resumed his university duties. Major Herms served with the Sanitary Corps of the United States Army for a little over a year, and since April, 1918, was stationed at the port of embarkation at Newport News, Va., where he was in charge of malarial drainage operations, delousing stations, and assisting in general sanitary inspection.

Mr. Edw. Doubleday Harris died at his home in Yonkers, N. Y., on March 2, after a few days' illness, in his eightieth year. He was born in Cambridge, Mass., September 30, 1839. He collected and studied the beetles of the family Cicindelidæ and several years ago presented his collection to the Museum of Comparative Zoölogy at Cambridge, Mass. In 1911, he published and distributed at his own expense, a small pamphlet entitled *North American Cicindelidæ in the Harris Collection.*

The following appointments are announced in the Bureau of Entomology: Douglas R. Royder, inspector sweet potato weevil work; J. N. Tenhet and S. F. Grubb, scientific assistants, tobacco insects; George G. Becker, agent for extension work, deciduous fruit insects, Arkansas; George B. Fisher, and G. W. Curtin, scientific assistants, Arlington, Mass.; J. Edward Taylor, alfalfa weevil demonstrations, Utah; Dr. R. S. McEwen, temporarily as artist; Wesley L. Miles, Arlington, Mass.; William Yetter, scientific assistant codling moth investigations, Grand Junction, Colo.; Dr. C. H. Richardson, insect physiologist, Washington, D. C.; Harry H. Stage, stored product insect investigations; Mortimer D. Leonard, extension work in truck crop insects in New York state.

Mr. Leonard S. McLaine, M. Sc., of the Canadian Entomological Branch, has been transferred from the Dominion Entomological Laboratory, Fredericton, N. B., to Ottawa, and has been appointed chief of the Division of Plant Inspection and executive assistant to the Dominion Entomologist. As chief of the Division of Plant Inspection, Mr. McLaine will have immediate charge of the work of inspection and fumigating imported nursery stock and of the field work against the brown-tail moth in eastern Canada and such other duties as the enforcement of the insects and pests regulations under the Destructive Insect and Pest Act may involve.

Recent transfers in the Bureau of Entomology are as follows: R. J. Fiske, Federal Horticultural Board to cereal and forage crop insect investigations, and assigned to work on the southern corn rootworm at Columbia, S. C.; C. F. Stahl, truck crop insects, Spreckels to Riverside, Calif.; W. H. Dumont, southern field crop insect investigations, Augusta, Ga., to Wilmington, N. C., and later to Mound, La.; R. W. Kelley, extension work with deciduous fruit insects in Indiana, to the Insecticide and Fungicide Board, and assigned to the laboratory at Vienna, Va.; E. E. Wehr, exten-

sion agent, insects injurious to domestic animals, Maryland to Indiana; W. H. Larrimer, cereal and forage insects in charge of field station, West Lafayette, Ind.; C. M. Packard from Berkeley, Calif., to have charge of field station at Hagerstown, Md.; M. C. Lane, Forest Grove, Ore., to Berkeley, Calif.; D. J. Caffrey, Hagerstown, Md., to Arlington, Mass., in charge of investigations on the European corn borer; E. J. Newcomber and W. D. Whitcomb to Yakima, Wash., to a new field station for the study of the codling moth and other deciduous fruit insects; E. R. Selkregg and B. R. Leach to Dover, Del., where a new laboratory has been established for study of the codling moth; C. H. Alden to Wallingford, Conn., C. K. Fisher, formerly at Wellington, Kan., to Wichita, Kan.; W. B. Turner, Hagerstown, Md., to Arlington, Mass.; F. L. Simanton, Benton Harbor, Mich., to Monticello, Fla.; W. A. Hoffman, Monticello, Fla., to Brownwood, Tex.; E. H. Siegler, Wallingford, Conn., to Washington, D. C.; A. O. Larson, extension work in deciduous fruit insects to Alhambra, Calif., to investigate pea and bean weevils in California; F. B. Milliken to Dallas, Tex., where a laboratory will be established for the study of the species of *Tribolium* and other mill pests.

The European corn borer work has been reorganized under Cereal and Forage Insect Investigations of the Bureau, with separate headquarters for the investigational and control activities. Investigational headquarters are located at No. 10 Court St., Arlington, Mass., and this work is now in full swing. The personnel at present is as follows: D. J. Caffrey, assistant in charge; H. E. Smith, entomological assistant; R. H. Van Zwaluwenburg; G. B. Fisher, W. B. Turner, C. W. Curtin, scientific assistants; J. H. Moore, field assistant; F. L. Pendergast, stenographic clerk; G. F. Greene, laborer. L. H. Worthley, formerly engaged under A. F. Burgess as agent in preventing spread of moths, has been placed in charge of the control work, with headquarters at 43 Tremont St., Boston, Mass. This phase of the work for the present will be carried on mainly under a fund especially appropriated by the state of Massachusetts in coöperation with the State Department of Agriculture. Saul Phillips has been appointed as assistant under Mr. Worthley for the field work, and entered upon his new duties on April 15. Mr. Phillips has had fifteen years of experience in insect control work in eastern Massachusetts, including gipsy and brown-tail moth work, and also considerable experience in mosquito control on the North Shore. He is, therefore, well equipped to handle the work which has been entrusted to his care. A force of 400 men was put to work cleaning up in the infested area on April 15, when the special state appropriation of $30,000 became available. It is expected that this work subsequently will be provided for by the Federal Government, if Congress agrees to allow a suitable appropriation for the work. Several methods of attacking the insect have been proposed, and are now being given a thorough trial. In view of the short period of time available before the moths emerge from their winter quarters, it probably will not be possible to treat effectively the entire infested area this spring.

Mailed June 28, 1919

EXCHANGES.

Exchanges or Wants of not over three lines will be inserted for 25 cents each to run as long as the space of this page will permit; the newer ones being added and the oldest dropped as necessary. Send all notices and cash to A. F. Burgess, Melrose Highlands, Mass., by the 15th of the month preceding publication.

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MELROSE HIGHLANDS, MASS.

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DRAWINGS for reproduction, oil color charts, and life history collections of economic insects prepared as desired.

H. E. HODGKISS and B. B. FULTON, 90 Lyceum St., Geneva, N. Y.

WANTED—Systematic and economic papers on the families *Bombyliidae* and *Asilidae*. Mail descriptive list of titles and prices desired. H. R. HAGAN, Utah Experiment Station, Logan, Utah.

WANTED—SYRPHIDAE—from all parts of the world. Will determine on the usual conditions. Address until June 15, Prof. C. L. METCALF, Bussey Institution, Forest Hills, Boston, Mass. Afterward Ohio State University, Dept. Entomology, Columbus, Ohio.

WANTED—Trans. Am. Entomological Society, Vol. 3; Lintners 3rd Report (1886); Entomological News, Vol. 2, No. 10 (Dec. 1891); Farmers' Bulletins 7, 8, 10, 12, 89, 117, 214, 268, 356, 556, 558, 839, 878, 905, 911.

P. T. BARNES, Department of Agriculture, Harrisburg, Pa.

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JOURNAL OF ECONOMIC ENTOMOLOGY

Official Organ of American Association of Economic Entomologists

A bi-monthly journal, published February to December, on the 15th of the month, devoted to the interests of Economic Entomology and publishing the official notices and proceedings of the American Association of Economic Entomologists. Address business communications to the Journal of Economic Entomology, Railroad Square, Concord, N. H.

TERMS OF SUBSCRIPTION. In the United States, Cuba, Mexico and Canada, two dollars and fifty cents ($2.50) annually in advance. To foreign countries, three dollars ($3.00) annually in advance. Single copies, fifty cents. To members of the American Association of Economic Entomologists, one dollar and fifty cents ($1.50) annually in advance. 50 cents extra for postage to foreign members.

MANUSCRIPT for publication should be sent to the Editor, E. Porter Felt, Nassau, Rens. Co., N. Y.

CURRENT NOTES AND NEWS should be sent to the Associate Editor, W. E Britton, Agricultural Experiment Station, New Haven, Conn

SUBSCRIPTIONS AND ADVERTISEMENTS may be sent to the Business Manager, A. F. Burgess, Melrose Highlands, Mass.

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[1]Withdrawn for publication elsewhere

JOURNAL
OF
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OFFICIAL ORGAN AMERICAN ASSOCIATION OF ECONOMIC ENTOMOLOGIST

Vol. 12 AUGUST, 1919 No. 4

Proceedings of the Pacific Slope Branch of the American Association of Economic Entomologists

Mission Inn, Riverside, California, May 28, 1919

MEMBERS PRESENT

Campbell, R. E., Bureau of Entomology, U. S. Dept. Agric., Alhambra, Cal.
Day, L. H., County Horticultural Commissioner, Hollister, Cal.
Doane, Prof. R. W., Stanford University, Cal.
Ehrhorn, E. M., Chief Plant Inspector, Honolulu, H. T.
Essig, E. O., University of California, Berkeley, Cal.
Gray, Prof. Geo. P., University of California, Berkeley, Cal.
Larson, A. O., Bureau of Entomology, U. S. Dept. Agric., Alhambra, Cal.
Ledyard, E. M., U. S. Smelter Co., Salt Lake City, Utah.
Mackie, D. B., California State Commission of Horticulture, Los Angeles, Cal.
Morris, E. L., County Horticultural Commissioner, Santa Ana, Cal.
Neuls, J. D., Braun Corporation, Los Angeles, Cal.
Penny, Donald, County Horticultural Commissioner, Watsonville, Cal.
Quayle, Prof. H. J., Citrus Experiment Station, Riverside, Cal.
Ryan, H. J., County Horticultural Commissioner, Los Angeles, Cal.
Smith, H. S., State Commission of Horticulture, Sacramento, Cal.
Stahl, C. F., Bureau of Entomology, U. S. Dept. Agric., Riverside, Cal.
Taylor, Prof. E. P., University of Arizona, Tucson, Ariz.
Urbhans, D. T., Bureau of Entomology, U. S. Dept. Agric., Berkeley, Cal.
Volck, W. H., California Spray Chemical Co., Watsonville, Cal.
Weldon, Geo. P., California State Commission of Horticulture, Sacramento, Cal.
Woglum, R. S., Bureau of Entomology, U. S. Dept. Agric., Alhambra, Cal.
Woodworth, H. E., County Horticultural Commissioner, San Mateo, Cal.

VISITING MEMBER

Marlatt, Dr. C. L., Federal Horticultural Board, Washington, D. C.

VISITORS

Armitage, H. M., State Commission of Horticulture, Alhambra, Cal.
Borden, A. D., Bureau of Entomology, U. S. Dept. Agric., Upland, Cal.
Bremner, O. E., County Horticultural Commissioner, Santa Rosa, Cal.
Brock, A. A., County Horticultural Commissioner, Santa Paula, Cal.
Carsner, Eubanks, Riverside, Cal.
Fawcett, Prof. H. S., Citrus Experiment Station, Riverside, Cal.
Gillis, H., Perth Amboy, N. J.
Gorton, G. R., County Horticultural Commissioner, San Diego, Cal.
Hadley, W. B., Horticultural Inspector, Redlands, Cal.
Houpt, L. O., County Horticultural Commissioner, Hanford, Cal.
Hurst, A. E., Covina, Cal.
Hurst, C. J., Covina, Cal.
Knight, Hugh, Citrus Experiment Station, Riverside, Cal.
Koller, J. M., Puente, Cal.
List, Geo. M., Chief Deputy State Entomologist, Fort Collins, Colo.
Mills, Earle, County Horticultural Commissioner, Oroville, Cal.
Newman, C. V., Limoneira Co., Santa Paula, Cal.
Roullard, Fred P., County Horticultural Commissioner, Fresno, Cal.
Rounds, M. B., Bureau of Entomology, U. S. Dept. Agric., Alhambra, Cal.
Strausz, A. L., State Horticulturist of Montana, Missoula, Mont.
Taylor, A. S., Redlands, Cal.
Taylor, F. H., County Horticultural Commissioner, Susanville, Cal.
Turner, C. F., County Horticultural Commissioner, Auburn, Cal.
Waite, F. W., County Horticultural Commissioner, El Centro, Cal.

BUSINESS SESSION

The business session of the Pacific Slope Branch of the American Association of Economic Entomologists was called to order in the Mission Inn, Riverside, California, at 4 o'clock p. m. by Chairman H. J. Quayle who announced the following committees:

Nominating Committee:
R. S. Woglum, Chairman
Geo. P. Gray
R. E. Campbell

Auditing Committee:
T. D. Urbhans, Chairman

Membership Committee:
H. E. Burke, 1 year
H. S. Smith, 2 years
R. W. Doane, 3 years

Chairman Quayle: A ten minute recess will be taken to permit the committees to formulate reports. (Adjournment for 10 minutes.)

Chairman Quayle: We will now hear the report of the Secretary-Treasurer.

E. O. Essig: Due to the absence of the Secretary at the last meeting no report was made, so that the following report is for the years 1917, 1918 and part of 1919:

PACIFIC SLOPE BRANCH AMERICAN ASSOCIATION OF ECONOMIC ENTOMOLOGISTS

Financial Statement, 1917–1919

Date	Item	Expenditures	Receipts
1917			
Jan. 1.	On hand		$23.91
Feb. 5.	Affiliation fee to A. A. A. Sci.	$5.00	
Apr. 2.	Large envelopes	.80	
	Multigraphing letters	1.25	
	Printing membership blanks	2.75	
18.	Express on proceedings to A. F. Burgess	.66	
May 1.	Refund from A. F. Burgess for disbursements		9.80
		$10.46	$33.71
	Balance		$23.25
1918			
Jan. 1.	On hand		$23.25
	Interest from Savings Bank		.69
Feb. 21.	Stamps, 1¢	$ .75	
	75 stamped envelopes, 2¢	1.61	
25.	50 stamped envelopes, 2¢	1.08	
	50 stamps, 1¢	.50	
May 2.	Express on proceedings to Dr. E. P. Felt	.57	
		$4.51	$23.94
	Balance		$19.43
1919			
Jan. 1.	On hand		$19.43
9.	100 stamped envelopes, 3¢	$3.14	
Feb. 4.	100 stamps, 1¢	1.00	
14.	100 stamped envelopes, 3¢	3.14	
12.	Affiliation fees, A. A. A. Sci. 1918	5.00	
	1919	5.00	
		$17.28	$19.43
	Balance		$2.15
Feb. 24.	On hand		$2.15
24.	Refund from A. F. Burgess to cover above expenditures		22.45
	Total amount on hand		$24.60

Respectfully submitted,

E. O. ESSIG,
Secretary and Treasurer.

CHAIRMAN QUAYLE: We will now hear the report of the Nominating Committee.

R. S. WOGLUM: Gentlemen, the Nominating Committee present the following names for officers for the ensuing year for the Pacific Slope Branch of the American Association of Economic Entomologists:

Chairman—E. M. Ehrhorn, Honolulu, H. T.

Vice-Chairman—R. W. Doane, Stanford University, Cal.

Secretary-Treasurer—E. O. Essig, Oxnard, Cal.

CHAIRMAN H. J. QUAYLE: I will now instruct the Secretary to cast the ballot electing the officers proposed by the Nominating Committee.

(Ballot cast by the Secretary.)

CHAIRMAN H. J. QUAYLE: Is there any further business to come before this meeting? If not I declare the meeting adjourned to meet the with Pacific Division of the American Association for the Advancement of Sciences wherever the latter association decides to meet during the year 1920.

PROCEEDINGS

The fourth regular annual meeting of the Pacific Slope Branch of the American Association of Economic Entomologists was held at the Mission Inn, Riverside, California, in connection with and as a part of the State Fruit Growers' Convention.

The meeting was called to order at 10 o'clock a. m. by the Chairman, Prof. H. J. Quayle.

As the Secretary had not yet arrived, Mr. Roy E. Campbell was elected Secretary *pro tem.*

Chairman H. J. Quayle opened the meeting with a few informal remarks and a welcome to all present. He suggested a closer coördination of the endeavors of Western entomological workers, specially urging coöperation in the selection and working out of problems of importance in order to eliminate duplication of effort in so far as such a plan was possible and practical. He then called upon several of those present to say a few words.

Those who were called were Dr. C. L. Marlatt, who brought a hearty word of welcome from the Entomological Society of Washington.

Mr. E. M. Ehrhorn briefly described the introduction of parasites into the Hawaiian Islands and told of the plant inspection service and new equipment for such work at Honolulu.

Mr. G. M. List spoke of the work being done in Colorado and brought greetings from the entomologists there who were unable to attend the meeting.

Chairman Quayle: The first paper on the program is entitled "A Suggestion of a Possible Control of Pea and Bean Weevils," by Mr. Roy E. Campbell, of the U. S. Bureau of Entomology, Alhambra, California.

A SUGGESTION OF A POSSIBLE CONTROL OF PEA AND BEAN WEEVILS

By Roy E. Campbell, *U. S. Bureau of Entomology, Alhambra, Cal.*

During the past several years, the writer has been making an investigation of the broad or horse bean weevil [*Laria* (*Bruchus*) *rufimana*][1] in California, and has observed an example of very good control or prevention of infestation by regulating the time of planting the seed. The opportunity is now taken to make a note of the observations with

[1] There seems to be some doubt about the proper name of this species. Dr. W. D. Pierce gives the generic name Mylabris Geoffroy precedence over Laria Scopoli and Bruchus Linneaus, while Dr. F. H. Chittenden favors the genus Laria.

the suggestion that the same methods might be applicable to the pea weevil [*Laria* (*Bruchus*) *pisorum*], and possibly to the several bean weevils. Dr. F. H. Chittenden is inclined to the belief that in some localities, such as Washington, D. C., where two crops of peas can be grown each year, late planting will result in sound seed stock, but according to available information, this is the first time the matter has been definitely followed for several seasons, and by a large number of observations and experiments the theory of late planting definitely proved.

The broad bean weevil is found in California wherever broad or horse beans are grown, but the principal districts are around San Francisco Bay, and down the coast to a little below San Luis Obispo. Alameda County formerly was the most extensive producing section, but due largely to heavy weevil infestation of practically all beans grown there, it is now of no commercial importance as a horse bean section. The following table, showing the infestation of broad beans from the Oceano-Morro and Sacramento districts, from numerous samples taken and tested by pure food inspectors of the Bureau of Chemistry,[1] and by the writer, is typical of all other districts.

TABLE I. SUMMARY OF THE 1916, 1917 AND 1918 CROP OF BROAD BEANS FROM THE OCEANO-MORRO AND SACRAMENTO DISTRICTS

District		1916 Per cent of infestation	1917 Per cent of infestation	1918 Per cent of infestation
Sacramento	Max.	41	63	84.3
	Min.	0	0	1
	Av.	9.09	12.7	22.4
Oceano-Morro	Max.	50	63	17.2
	Min.	0	0	0
	Av.	14.5	14.5	2.92

Sacramento is the newest horse bean section, and a glance at the table will show that not only the maximum per cent of weevil infestation of beans produced there, but also the average, increased each year. The low percentage for the Oceano-Morro sections for 1918 will be explained later.

Life History

The eggs are laid on the surface of the green bean pods in the field. No eggs were observed by the writer except on the pods, the latter varying in size from less than an inch to over five inches. Most of the eggs are laid on the larger pods.

[1] The writer is indebted to the Western Division of the Bureau of Chemistry, and Mr. M. A. Rex, pure food inspector, for supplying all the data they had collected on the horse bean crop of California for the last four years.

The eggs hatch in from 9 to 18 days, the young larvæ boring directly into the pod, and from thence into the nearest bean, in which they feed during the remainder of the larval life. The duration of the latter is from 10 to 15 weeks. Pupation takes place within the bean, in the cell eaten out by the larva, and requires from 7 to 16 days.

The adult may emerge from the bean immediately, or remain within it for several months. The length of the adult life is from 1 to 8 months.

Seasonal History

While the first eggs are laid soon after the middle of March, and a few may be laid as late as the middle of May, the most extensive deposition occurs during the month of April. Larvæ may be found from the latter part of March to the middle of October; pupæ from the first of August to the latter part of October, and adults from the middle of August to the following June.

Although a few adults live until June, by far the greater number die off several months sooner. In storage 90 per cent of the weevils are dead by the first of April. Field observations at Hayward showed that the first active weevils were observed in broad bean fields on March 25, that the number increased until May 4, after which it decreased constantly until June 15, the last date any live adults were observed in the field.

Cultural Methods of Control

Time of Planting

The planting season for horse beans begins soon after the first fall rains, usually in October or November, and continues until late spring. Horse bean buyers and growers have noticed for some time that beans from seed planted early in the season usually have a higher percentage of weevil infestation than beans from seed planted later. This was checked up by making a table from the data collected by the Bureau of Chemistry, whose inspectors, when taking samples of horse beans, ascertained as far as possible when the seed had been planted. About 20,000 sacks from seed planted early, that is before January 1, in 1916 and 1917, gave an average of slightly over 33 per cent of the beans infested, while about 7,500 sacks from seed planted late, or after March 1, averaged 6.4 per cent weevil infested.

From numerous samples taken of crops planted in certain months in the three seasons, 1916 to 1918 inclusive, the following averages were obtained:

Table II. Comparison of the Per Cent of Weevil Infestation of Horse Beans Planted in Different Months. Figures are Averages for the Three Years, 1916, 1917 and 1918

Month Planted	Oct.	Nov.	Dec.	Jan.	Feb.	Mar.	Apr.	May
Per cent infested	46	42.3	16.6	16.7	9.7	11.5	2.6	.4

This was further tested by experimental plantings at Alhambra and Hayward during the season of 1917 and 1918, with the following results:

Table III. Averages of the Per Cent of Weevil Infestation in Experimental Plantings at Alhambra and Hayward, during 1917 and 1918

Month Planted	Nov.	Dec.	Jan.	Feb.	Mar.	Apr.	May
Per cent infested..............	53.8	34.9	14.9	11	5.4	4	3.5

It is plainly evident from these tables that the percentage of infestation is very much less in crops from seed planted late in the season than from crops which were planted early. The life history of the insect suggests an explanation of this. It was observed that egg deposition began about March 15, was heaviest in April and ended by the middle of May. It seems reasonable to believe that pods produced before or during April will be exposed to the greatest egg laying, but pods produced after the latter part of April will be subject to little or no egg deposition.

Further evidence on this point is furnished by horse bean growers of San Luis Obispo County. It had been the custom there, as elsewhere, to begin planting in October or November and continue until May. But because of severe infestation of the bean aphis (*Aphis rumicis* L.) on the early planted horse beans for several years, and on the contention that horse beans acted as a winter host for this pest, propagating it in great numbers, the County Horticultural Commissioner persuaded the growers not to plant any horse beans until after March 1, in the 1918 season. The result is shown in Table I, with a maximum of 50 and 63 per cent of weevil infestation, and averages of 14.5 per cent for the 1916 and 1917 crops when the seed was planted both early and late, as contrasted with a maximum of only 17.2 per cent and an average of 2.92 per cent of weevil infestation for the 1918 crop, when no seed was planted until after March 1. Many samples of this season's crop were entirely free from infestation, particularly those from seed planted in April and May.

When the first observations were made on the effect of late planting, it was suggested that with an abundance of pods available on which to

oviposit, the females became spent early in the season, which resulted in little or no infestation of beans produced late, but if there were no pods in the early part of the season, the females would merely hold over until pods were available. The above data definitely shows this suggestion not to be the case, because although there were few or no horse bean pods in San Luis Obispo County during the regular egg laying season of 1918, the females were quite apparently unable to hold over and deposit eggs on the later produced pods.

Therefore, from the figures given in the tables and the experience of San Luis Obispo County, the efficiency of late planting as a control for the horse bean weevil is definitely proved. It should be noted, in passing, that late planting can only be practised where there is an abundance of soil moisture, or plenty of water for irrigation, and in localities where the spring weather is not too hot or dry.

Since the pea weevil has a very similar life history, will not such methods also apply to it?

Chairman Quayle: The next paper will be presented by Mr. Harry S. Smith, Superintendent of the State Insectary of the State Commission of Horticulture, Sacramento, California. He will speak "On Some Phases of Insect Control by the Biological Method."

ON SOME PHASES OF INSECT CONTROL BY THE BIOLOGICAL METHOD[1]

By Harry S. Smith, *California State Commission of Horticulture, Sacramento, California*

The biological method of insect pest control, broadly speaking, embraces the use of all natural organic checks, bacterial and fungous diseases as well as parasitic and predaceous insects. The remarks in this paper, however, refer to the use of entomophagous insects only, since the writer has not had an opportunity to make observations on the diseases on insects, and conditions in California do not seem in general to favor their use as means of pest control.

From a practical standpoint the biological method may be arbitrarily divided into two sections: *First,* is the introduction of new entomophagous insects which do not occur in the infested region; and *second,* the increasing, by artificial manipulation, of the individuals of a species already present in the infested region, in such a way as to bring about a higher mortality in their host than would

[1] Occasional contributions from the California State Insectary, No. VI.

have occurred if left to act under normal conditions. The *first* embraces only the establishment of a species in the local fauna, while the *second* involves an attempt to make the entomophagous insects continually dominate their host, a condition which cannot prevail if nature is left to act unaided.

So far as the first section of biological control is concerned, entomologists are, it is believed, pretty well agreed that the introduction of as many new beneficial insects as may be obtained is desirable, provided only that the work is done with an intelligent understanding of the interrelations of entomophagous insects. Dr. L. O. Howard states that " . . . since there exist all over the world beneficial insects, many of which can undoubtedly be acclimatized here, and some of which will undoubtedly prove of value to American agriculture, carefully planned work should be begun looking to the ultimate increase of our insect population by the addition of as many of the beneficial forms as possible." It is hardly necessary to add that such introductions should be made with a proper appreciation of the possible results to be obtained and, because of its retarding effect on the use of other means of control, over-optimistic and premature advertising should be carefully avoided.

The other section or type of work with entomophagous insects, that embracing the artificial manipulation of species already established in the infested area in such a way as to increase greatly their numbers and thus to decrease the numbers of their host, has not been looked upon with equally great favor by entomologists.

Biological control by this latter method is based on the proposition that fluctuation in abundance of host and parasites may be prevented and the host insect kept permanently in subjugation, by maintaining a super-abundance of natural enemies in the orchard or field at all times. The "balance of nature" is like a pendulum, swinging to and fro, the dominance of any species alternating with that of its natural checks. The method of control here under consideration is based on the assumption that by artificial manipulation the natural checks can be made to permanently dominate the species against which they exert a controlling influence. There may exist a perfect "balance" in the relation between a species and its host and the host still be a pest because the number of individuals occurring at the time of greatest abundance is sufficient to damage cultivated crops. It is a well-known fact that in the relation between host-insect and its natural checks there is a point where the natural enemies, having temporarily dominated the host, themselves become almost extinct, with the result that the remaining individuals of the host are again permitted to breed almost without hindrance. This is the strong vantage-point

in attack by the biological method because if we can liberate a surplus of natural enemies of the pest when they are normally at low ebb, the host also being scarce we should be able to prevent the host insect from gaining that ascendency which makes it sooner or later a pest. Under these conditions many of the natural enemies would, of course, die from starvation and the premises would have to be restocked from time to time.

From a biological standpoint the proposition seems a sound one, but what entomologists and agriculturists want to know is whether or not it can be put into practice. The writer believes that there are fundamental principles involved in this work which in the case of certain pests would so limit the possibilities that an attempt to apply it to field conditions would not be justifiable, while in the case of other pests, or under other conditions, the opposite would be true. In other words, a decision as to its applicability in the control of any pest should be arrived at only after a careful study of each individual case with reference to the limiting factors.

Among the factors which govern the possibilities in this direction the following are important:

1. Comparative Reproductive Capacity of Host and Available Entomophagous Insects. This is obviously of much importance. If the host insect breeds with great rapidity and the only available entomophagous insects are of low reproductive capacity, success in the attempt could hardly be expected.

2. Power of Locomotion of Pest and Natural Enemies. As a general rule attempts to control an insect pest by the biological method will be undertaken locally, and not over the entire range of the insect. If the pest is an active flier, its ability to continually and quickly reinfest the area where the attempt is being made would react unfavorably on the effort. If the entomophagous insects are active fliers it is possible that their tendency to disperse rapidly from the place of liberation may also work against the success of the undertaking.

3. Sequence of Available Entomophagous Insects. It is very desirable, especially where use is being made of parasitic rather than predaceous insects, that there be a complete sequence of parasites affecting the egg, larva and pupa of the pest. This is for the reason that multiple parasitism, or parasitism by two or more different species in the same individual of the host insect, at times reduces the efficiency of the parasites as a whole. The ideal arrangement would be a single efficient parasite for each of the three stages of the host, but this is not a necessity, especially if predaceous insects are also employed.

4. Possibility of Rearing or Obtaining the Entomophagous Insects in Sufficient Quantities. This is one of the most impor-

tant factors, and probably is the one which will, more often than any of the others, work against the success of such undertakings. Unless the beneficial insects can be either reared or collected in great numbers success will not be possible. In cases where the entomophagous insect takes readily to rearing in confinement, the possibility of rearing or obtaining a host insect in quantity is what limits the undertaking. This is in turn limited by the availability of a host plant upon which to grow the host-insect. In any event the beneficial insects must be had in sufficiently large quantities that they will be enabled to overcome the pest in the field.

5. Cost of Producing Natural Enemies in Comparison with Value of Crop and with Artificial Control, if any. The factor of cost of production is, of course, one of the most important, since the main objective sought in biological control is economy. The cost should not even closely approach that of effective artificial control if such exists. In the case of the mealy-bugs, where there is no very satisfactory artificial control known, the cost factor is not of such very great importance, yet it obviously must remain well within the bounds of profitable crop production.

6. Presence of Secondary Parasites in the Local Fauna. The retarding effect of the existence in the local fauna of secondary parasites that will strongly attack those with which the work is being carried on, must be taken into consideration. Undoubtedly it will in some cases be sufficient to render the work unsuccessful, because if by artificial manipulation a superabundance of natural enemies of the pest is created, conditions will then be ideal for the secondary parasites. In most cases it will be practically impossible to foresee just what would occur in cases of this kind and a practical attempt would have to be made in order to ascertain just what part the secondary parasites, and the primary parasites of the predaceous insects, would play. Undoubtedly this factor will limit, or entirely prevent, the control of many of our insect pests by this method.

7. Unfavorable Agricultural Practice. Under conditions where certain agricultural practices are essential, these will in some cases perhaps make efforts at biological control inadvisable. For example, if an orchard is infested with two or more insect pests, one of which can be controlled by the biological method and the other cannot be, the latter requiring artificial treatment such as fumigation or spraying, such practices, affecting adversely the breeding of natural enemies, would make it impractical to attempt to apply the biological method as a control for the other pest.

These are, it is believed, the most important factors which must be taken into consideration, in contemplation of any project on the

biological control of insect pests. There are, of course, many others of lesser importance, such as the occurrence of ants in scale-infested orchards, cases where the pest exists on a short-lived crop, etc., but time will not permit of their being mentioned, nor the discussion of the others in detail. This brief outline will perhaps, however, give some idea of the several factors which will influence, either favorably or unfavorably, attempts to put the biological method into practice.

This type of pest control has already been put to practical use in a limited way in California, and has proven to be a complete success. The citrus mealy-bug, which has been one of the most difficult to control of all the citrus pests, has been brought into complete subjection in several orchards in southern California, through the continued liberation of large numbers of entomophagous insects, principally *Cryptolaemus montrouzieri*. These were in part reared by the State Insectary, by the use of the potato sprout method developed by the writer, and in part collected in orchards where they had become abundant late in the season. One cannot, of course, conclude from this that the method will prove equally successful against other pests, but it does indicate that, where conditions are favorable, results may be obtained which will go far toward bringing about economy in pest control.

The discussion of this paper was led by Mr. R. S. Woglum and J. D. Neuls.

Chairman H. J. Quayle: The next paper entitled "Observations on Some Mealy-Bugs" will be read by the Secretary in the absence of the author Mr. G. F. Ferris:

OBSERVATIONS ON SOME MEALY-BUGS (HEMIPTERA; COCCIDAE)

By G. F. Ferris, *Stanford University, Cal.*

The following notes have to do for the most part with certain species which are already of economic importance or may be regarded as awaiting only a favorable opportunity to become so.

1. The proper name of the "Citrophilus" mealy-bug. Unfortunately the name, *Pseudococcus citrophilus*, given by Claussen to this pernicious species cannot stand, for the species had been described only a few months before by Mr. E. E. Green[1] as *Pseudococcus gahani*, from specimens taken from *Ribes sanguinea* in London, England.

[1] Green, E. E., Ent. Mon. Mag., 51: 179; pl. 16, figs. 4–5. (May, 1915.)

Suspecting, from the description and figures given by Green, that the two were identical I forwarded specimens to him for comparison. He informs me that the two are undoubtedly the same. This record is a matter of some interest as the species had not before been recorded outside of California. Here it is without much doubt an introduced species and as its original home is unknown all records of its occurrence in other lands are of importance as affording possible clues to its origin. However, I am inclined to think that it is an alien in England as well as here, for it seems doubtful that such a species would so long have remained unnoticed.

The necessity of changing a name as well known as this affords a strong argument against the practice of adopting the scientific name of a species as its common name also. It may as well be recognized that in this group especially stability in nomenclature will certainly not be arrived at for many years to come. This is an unfortunate condition but it may be greatly ameliorated by the adoption of well chosen vernacular names. It is also to be taken as evidence of the necessity of studying the scale insects from collections representing the widest possible geographical range and not from merely local faunas.

2. *Pseudococcus maritimus* (Ehrh.) in England and Florida. From Mr. E. E. Green I have received for determination specimens of a mealy-bug which he informs me occurs on various plants in green-houses in England. This is certainly *P. maritimus* (Ehrh.) (= *P. bakeri* Essig), which has not before been recorded from any point outside of the United States.

From Mr. J. Chaffin of the State Plant Board of Florida I have received this same species, from sweet potato, tomato and avocado on the Dry Tortugas Islands near Key West. It has not before been recorded from this portion of the United States.

3. *Pseudococcus pini* (Kuwana) in California. From Mr. H. S. Smith I have received specimens of this species from pine in a Japanese nursery at Oakland. It was originally described from Japan and has not previously been reported from this country, although Mr. Ehrhorn informs me that he has seen what was probably this species on pines in a nursery at San Jose. I append a redescription of the species.

4. *Pseudococcus bromeliae* (Bouché) in Florida. This species appears regularly in the "Reports of Pests Intercepted" by the various quarantine offices but, as far as I am aware, has not been recorded as established in the United States. From Mr. Chaffin I have received specimens from roots of banana at Florence Villa, pineapple at Frost Proof and citrus at Ft. Meyers, Florida. The existing descriptions are quite inadequate and I append a redescription.

5. *Pseudoccocus virgatus* (Ckll.) in Florida. This widely distributed

tropical species appears to have been recorded but once from the United States, from "cactus and other plants" at Brownsville, Texas. From Mr. J. Chaffin and Mr. C. J. Drake I have received specimens taken from Magnolia and mulberry at Gainesville, Oleander at Key West and "undetermined weed" at Winter Haven, Florida. I append a redescription of this species also.

6. *Pseudococcus comstocki* (Kuwana), a dangerous mealy-bug. *Pseudococcus comstocki* (Kuwana) was originally described from specimens taken from mulberry and maple in Japan. In a sending of mealy-bugs recently received from Mr. Kuwana there were included specimens of this species from a long series of hosts, including the following: *Castanea*, cherry, citrus, *Eleagnus*, *Euonymus*, *Kraunhia*, melon, persimmon and peach. What is unmistakably the same species occurs in the eastern part of the United States, Professor Doane having taken specimens from apple, horsechestnut, *Hydrangea*, maple, mulberry, wild cherry and some other hosts on Staten Island, New York. Professor Doane informs me that in this locality the species is a serious pest and that some of the mulberry trees have been much injured by it. I have received the same species from various hosts in Maryland, also.

From the facts recited above it is obvious that this species is a worthy candidate for admission to that select fraternity which includes *Pseudococcus citri*, *gahani*, *longispinus* and *maritimus*. Its introduction into California is certainly to be feared.

There occurs on the Monterey pines on the Campus of Stanford University a mealy-bug that I have not been able to separate from *P. comstocki*. However, the behavior of these local representatives is beyond reproach. They appear to be confined to the pines; they are relatively few; they are heavily parasitized; there are apparently but one or two generations per year. It is probable that this represents a monophagous strain or race of this species and that its spread to other hosts is not to be feared.

I have described this species in an earlier paper dealing with the California species of mealy-bugs and shall not consider it further here.

The Mealy-Bug at Ojai

From Mr. H. S. Smith and from Mr. E. O. Essig I have received specimens of a mealy-bug taken from citrus at Ojai. In regard to the identity of this species there is unquestionably room for argument. Basing my opinion entirely upon slide mounts I have said that while the species is undoubtedly very close to *P. citri* it is apparently distinct and that of the species known to me it most closely approaches *P. kraunhiæ* (Kuwana) from Japan. Extreme examples are easily

separable from *citri* but it must be admitted that some examples are not. The form may be merely an extreme variant of *citri* or it may be a race or strain—call it what you please.

Mr. Smith and Mr. Armitage inform me that from field observations they are convinced that this is not *citri* and Mr. Woglum states that from a superficial examination only he too is inclined to agree with this viewpoint. I have previously noted the species in my paper on the California mealy-bugs but in view of its possible importance and its close resemblance to *citri* more extended studies are desirable, the description which I have given needing to be amplified. I shall not here attempt such a study.

Descriptions of Species

Pseudococcus pini (Kuwana)

Fig. 15. *Pseudococcus pini* (Kuwana): left, anal lobe and penultimate cerarii; right, ventral side of anal lobe.

Habit. The original description of this species contains but little information concerning its appearance in life, nor, from the material that I have examined can I add anything. Judging from the morphology of the species, however, it will have much the appearance of *P. citri*, but the marginal tassels will not be present anterior to the abdomen. The species probably does not secrete a large ovisac. Body contents reddish.

Morphological Characteristics. With but five or six pairs of cerarii, these on the last five or six segments of the abdomen. Each cerarius with two rather slender, conical spines, with a very few pores and without auxiliary setæ except for a few about the anal lobe pair. Spines of the anal lobe cerarii largest, the others becoming progressively smaller anteriorly. Ventral side of the anal lobes normally with a small but well defined, chitinized bar extending in from the base of the minor seta. There is some variation in this character and in some specimens it appears not to be developed. Spines of the dorsum rather few and small, their bases rather stout, their tips tending to be somewhat flagellate, those of the head longer and more slender than the others. Ventral setæ longer and more slender than those of the dorsum.

Tubular ducts apparently few, all small and without a raised rim about the mouth, not at all concentrated near the lateral margins of the abdominal segments. Legs and antennæ presenting no distinctive characters. Anal lobe and anal ring setæ approximately equal, two or three times as long as the diameter of the anal ring.

Material Examined. Specimens from the type material; from pine, Kiushiu, Japan; from *Pinus thunbergii*, Yokohama, Japan; from pine in a Japanese nursery at Oakland, California.

Notes. This species very closely resembles another that I take to be *P. azaleæ* (Tins.), of which I have specimens from numerous hosts in Japan. The two differ chiefly in the fact that in the latter species the tubular ducts are very numerous and are concentrated near the lateral margins of the abdominal segments and also in the fact that in this species the derm of the adult tends to be of a bluish color and the body contents black.

Pseudococcus bromeliæ (Bouché)

Fig. 16. *Pseudococcus bromeliæ* (Bouché): left, penultimate and anal lobe cerarii; right, ventral side of anal lobe; above a disproportionately enlarged dorsal spine.

Habit. The existing descriptions of the species are not especially definite in regard to the appearance of the species in life and I can add but little. The marginal tassels are quite long, the caudal pair being but little longer than the others. Apparently the species does not form an ovisac.

Morphological Characteristics. With seventeen pairs of cerarii, all with auxiliary setæ, with numerous pores and in part with three or more cerarian spines. There is some variation in regard to the number of cerarian spines but in general the arrangement is as follows. Anal lobe pair always with but two; four or five pairs anterior to these and the first three on the head normally with three or four spines; remainder normally with but two. The spines of the anal lobe pair are largest. No chitinized areas about any of the cerarii, except sometimes a faintly indicated area

about those of the anal lobes. Ventral side of the anal lobes with a quite large chitinized area extending in from the base of the anal lobe setæ. Dorsal body setæ rather few, small, stiff. Ventral setæ likewise few, slender, longer than those of the dorsum. Tubular ducts for the most part confined to the venter, all small and without a raised rim about the mouth. Anal ring of ordinary character. Anal lobe and anal ring setæ about equal, about one and one-half times as long as the diameter of the anal ring. Antennæ and legs presenting no unusual characters.

Material Examined. From pineapples at quarantine from Hawaii and West Indies; from roots of banana at Florence Villa; pineapple at Frost Proof and citrus at Ft. Meyers, Florida.

Pseudococcus virgatus (Ckll.)

Fig. 17. *Pseudococcus virgatus* (Ckll.): dorsal aspect of anal lobe and portion of penultimate segment.

Habit. A rather slender form, attaining a length of 4.5 mm. Thinly dusted with powdery secretion, with a pair of longitudinal submedian dark stripes. Caudal tassels attaining about half the length of the body, lateral tassels lacking. Dorsum bearing numerous delicate, glassy, waxen threads which arise from near the margins. Viviparous.

Morphological Characteristics. With but a single pair of cerarii, these on the rather prominent anal lobes, each with two (or sometimes three) quite large cerarian spines, numerous, but scattered, pores and a few slender setæ. The cerarii are not surrounded by a chitinized area. Ventral side of the anal lobes sometimes with a very small, chitinized area, which is normally lacking. The most conspicuous feature of the species is the presence of numerous, unusually large ducts, the mouths of which are surrounded by a small, chitinized area which bears from one to four small setæ. It is from these ducts that the glassy threads, which are so conspicuous in the living insect, arise. The arrangement of these ducts is fairly definite. Except for a

median pair on three or four abdominal segments and an occasional duct on the dorsum of the thorax they are confined to the lateral margins, there being normally six or seven at each lateral margin of the penultimate segment and two or three at each lateral margin of the other abdominal segments (except the last) and the thoracic segments also, together with an indefinite number on the head. Dorsal body setæ relatively few, small and slender. Ventral setæ much longer. Anal ring noticeably large, rather weakly developed. Anal ring setæ about twice as long as the diameter of the anal ring and slightly shorter than the anal lobe setæ. Antennæ and legs rather slender, the antennæ eight-segmented, the claw without a tooth.

Material Examined. From various hosts in Hawaii, Philippine Islands and Nicaragua and from the following hosts and localities in Florida; mulberry and *Magnolia* at Gainesville; undetermined weed at Winter Haven; *Oleander* at Key West.

Notes. This is far from being a typical *Pseudococcus*. In the nature of the ducts it resembles *Phenacoccus stachyos* Ehrh., but the latter has nine-segmented antennæ, eighteen pairs of cerarii and a tooth on the claw.

Synonymy of Some Coccidæ

Pseudococcus quercus (Ehrh.)

1900. *Dactylopius quercus* Ehrh., Can. Ent., 32: 220. (Part.)
1910. *Pseudococcus agrifoliæ* Essig; Essig, Pomona Col. Jn. Ent., 2: 147–148, figs. 60B, 60C. (Misidentification.)
1918. *Pseudococcus quercicolus* Ferris, Calif. Species Mealy-Bugs, Stanford Univ. Publ., p. 50, pl. 2, f. 18.

Through the kindness of Mr. Ehrhorn I have been enabled to examine the type slide of *Pseudococcus quercus*. The slide contains two specimens, of which one is *P. crawii* (Coq.) and the other *P. quercicolus* Ferris. This being the case the name *quercus*, which I have previously placed as a synonym of *crawii* may be revived for *P. quercicolus*.

Lachnodius phoradendri(Ckll.)

1912. *Pseudococcus phoradendri* Ckll., Jn. N. Y. Ent. Soc., 20: 133.
1919. *Lachnodius salicis* Ferris, Contrib. Knowl. Coccidæ Sw. U. S., Stanford Univ. Publ., p. 23, f. 7.

Through the kindness of Professor Cockerell I have been enabled to see a slide from the type material of *Pseudococcus phoradendri* Ckll. There can be but little doubt that my *Lachnodius salicis* is the same.

Cryptoripersia arizonensis (Ehrh.)

1899. *Ripersia arizonensis* Ehrh., Can. Ent., 31: 5.
1901. *Ripersia trichura* Ckll., Ann. Mag. Nat. Hist. (7), 7: 55.
1911. *Eriococcus salinus* Ehrh., Can. Ent., 43: 276.

1918. *Cryptoripersia salinus* (Ehrh.); Ferris, Calif. Species Mealy-Bugs, Stanford Univ. Publ., p. 74, pl. 3, f. 30.

1919. *Cryptoripersia arizonensis* (Ehrh.); Ferris, Contrib. Knowl. Coccidæ Sw. U. S., Stanford Univ. Publ., p. 34.

Professor Cockerell has kindly sent me a slide of his *Ripersia trichura* from the type material. This is structurally identical with *C. arizonensis* (Ehrh.). The fact that the specimens are smaller than *arizonensis* and were not enclosed in a sac may be taken merely as evidence that they were not fully grown.

The paper on mealy-bugs was received with much interest and a general discussion was entered into, led by H. S. Smith, E. M. Ehrhorn, A. A. Brock, R. S. Woglum.

Chairman H. J. Quayle: The next topic on the program is an illustrated lecture by Mr. D. B. Mackie, southern field deputy of the State Commission of Horticulture on "Migratory Locusts in the Philippine Islands." Mr. Mackie has had a large experience in entomological work in the Philippines and his talk will be very interesting I am sure.

(No paper was presented for publication.)

Chairman H. J. Quayle: This will end the program for this morning. The proceedings will be continued at the same place this afternoon beginning at 2 o'clock p. m. (Recess.)

Afternoon Meeting

The meeting was called to order by Chairman H. J. Quayle at 2 p. m. E. O. Essig acted as Secretary.

Chairman H. J. Quayle: The first paper this afternnon will be presented by Mr. Geo. M. List, whose subject is "The Alfalfa Weevil in Colorado."

(Paper withdrawn for publication elsewhere.)

Chairman H. J. Quayle: Prof. George P. Gray of the Insecticide Laboratory of the University of California has recently conducted some very interesting investigations relative to liquid hydrocyanic acid gas. He will present the next paper entitled "The Physical and Chemical Properties of Liquid Hydrocyanic Acid."

(Paper withdrawn for publication elsewhere.)

Chairman H. J. Quayle: Inasmuch as there are several other papers yet to follow on this subject of liquid hydrocyanic acid gas, I am going to suggest that we defer discussion until after all of the speakers have finished.

The next paper by Mr. R. S. Woglum of the Bureau of Entomology

is entitled "A Dosage Schedule for Citrus Trees with Liquid Hydrocyanic Acid."

(Paper not presented for publication.)

CHAIRMAN H. J. QUAYLE: The next paper is entitled "The Stratification of Liquid Hydrocyanic Acid as Related to Orchard Fumigation." It has been prepared by Mr. R. S. Woglum and M. B. Rounds both of the Bureau of Entomology and will be presented by Mr. Rounds.

THE STRATIFICATION OF LIQUID HYDROCYANIC ACID AS RELATED TO ORCHARD FUMIGATION

By R. S. WOGLUM and M. B. ROUNDS, *Bureau of Entomology, Department of Agriculture, Alhambra, Cal.*

The use in orchard fumigation in California of liquid hydrocyanic acid sometimes containing a large per cent of water has brought forth the question "Does this chemical ever stratify?" The prevalent opinion among those who have worked most with this active agent appears to be that stratification is improbable even when liquid hydrocyanic acid of widely different strengths or even liquid hydrocyanic acid and water are brought together in any proportion, and this view, at first, was accepted by the writers. The definite assertion to the senior writer by Mr. S. A. Stowell, an experienced fumigator, that he had drawn water and hydrocyanic acid from the same drum led to the outlining of a series of experiments in an endeavor to settle this point.

The first experiment which was performed by Mr. H. D. Young by slowly bringing together liquid hydrocyanic acid and tap water gave definite stratification. This preliminary experiment was followed by many others during which liquid hydrocyanic acid was added to tap and distilled water and vice versa; also liquid hydrocyanic acid of widely separated purities were brought together. In this work glass bottles were used each first being half-filled with material to which the second liquid was added slowly by means of a pipette. The bottles were not shaken. Typical experiments are herewith presented in brief.

In each of these eleven experiments stratification occurred regardless of the order in which the different liquids were added; the effect was similar whether the water was added to the hydrocyanic acid or the hydrocyanic acid to the water. Distilled water reacted in a manner similar to tap water. Each of these experiments was repeated and many others of like nature were performed. In every instance in

TABLE 1. TABLE REPRESENTING THE RESULTS OF EXPERIMENTS ON STRATIFICATION

Experiment Number	Size of Bottle	Liquid in Lower Half of Bottle	Liquid Added to Half-Filled Bottle	Cloudiness of Milky Appearance	Stratification
1	1 gal.	tap water	92% HCN	Yes	Yes
2	1 gal.	{ ½ tap water ½ 50% HCN[1] }	½ 92% "	"	"
3	1 gal.	½ 50% " [1]	½ 92% "	"	"
4	8 oz.	tap water	96% "	"	"
5	"	dis. water	96% "	"	"
6	"	96% HCN	dis. water	"	"
7	"	tap water	91% HCN	No	"
8	"	dis. water	91% "	No	"
9	"	50% HCN[1]	92% "	Yes	"
10	"	92% "	dis. water	No	"
11	"	92% "	tap water	No	"

[1] Cloudiness in sample formed by diluting 96 per cent hydrocyanic acid to make a 50 per cent solution.

which the liquids were brought together slowly, stratification occurred. One series of bottles left undisturbed for several weeks showed distinct stratificiation throughout this period. If, however, the materials were brought together violently and thoroughly shaken stratification was not produced.

When liquid hydrocyanic acid was allowed to flow slowly into water near the surface level it rose to the surface and did not mix freely with the water. Ultimately a layer or stratum was formed between the heavier lower liquid and the lighter upper one. When water was added slowly to liquid hydrocyanic acid it flowed through the liquid to the bottom of the bottle forcing the lighter chemical to the top, and showed a distinct stratum between the two liquids. In some cases this stratum between the two liquids was transparent and detected only by close examination, or agitation of the bottle. In other cases a cloudiness or milky appearance was observed when water and hydrocyanic acid were mixed and this precipitate ultimately collected in the middle layer to which it gave a whitish gelatinous appearance. (Pl. 14, fig. 1.) When allowed to stand in bottles undisturbed for a short time a vigorous shaking was necessary to break up this layer.

This milkiness occured only with liquid hydrocyanic acid taken from galvanized iron drums. A chemical examination of the acid taken from drums showed it to contain traces of zinc in solution whereas the liquid hydrocyanic acid which produced no precipitate had been in glass containers and upon examination was found to contain no zinc. Since zinc was in solution in the liquid hydrocyanic acid and since zinc compounds with cyanogen are known to be insoluble in water, it would seem apparent that the precipitate formed was some compound of this metal. The presence of a gelatinous precipitate

in the bottom of drums and in machines for applying the gas was often noted in field work during this past season, and was a source of interference with accurate action of the pump.

Actual proof of the fact that where liquids of widely varying purity are brought together stratification may take place and the relation thereto of zinc compounds present features of importance in field practice. In the first place only liquids of uniformly high purity should be used thereby to prevent stratification which might occur if materials of widely different strengths from two or more containers are poured together. Metals containing zinc should not be brought in contact with liquid hydrocyanic acid. When drums are washed out with water after use in the field they should be thoroughly dried before being refilled. Furthermore, that stratification may hasten decomposition is shown by one experiment in which a gallon bottle half full of tap water was filled with 92 per cent hydrocyanic acid from a galvanized iron drum. A few days following the experiment decomposition started immediately below the middle layer which held the precipitate and within two weeks the lower half of the bottle was dark brown in color. The top layer remained perfectly clear until the completion of the experiment when the bottle was discarded to avoid explosion.

Chairman H. J. Quayle: These three papers are now open for discussion.

Prof. Geo. P. Gray: Our conclusions are the same regarding liquid HCN and its ability to stratify.

R. S. Woglum: There are a few rather interesting points which I wish to call your attention to in connection with our studies of liquid HCN.

Where the liquid is taken from iron drums the gelatine percipitate is hard to mix with the liquid HCN and stratification may be present when it is used.

There has been more daylight fumigation during the past summer with liquid HCN than ever before under the old system of fumigation. However I do not believe in daylight fumigation because the chances for burning are too great. In hot weather the gas from liquid HCN stays near the bottom of the tents and gives relatively better killings in the lower portions of the trees. At 40° F. the killing is rather poor, although it may be said that in lower temperatures the best killings are at the top of the trees.

Chairman H. J. Quayle: Our experiences show that there is less diffusion in low temperatures. At a temperature of 50° F. there

Experiments 1 to 3 showing stratification which resulted when widely different strengths of liquid hydrocyanic acid, or when liquid hydrocyanic acid and water were slowly brought together. Liquid hydrocyanic acid contained traces of zinc.

is a difference of 10 per cent between the top and bottom of the tent with the greater concentration and killing at the bottom. At a temperature of 70° F. there is better diffusion and a more even killing throughout the whole tent.

If there is no further discussion we shall pass on to the next paper which was to have been presented by Dr. H. P. Severin of the University of California. As he could not be present I am going to ask Mr. C. F. Stahl, of the Bureau of Entomology, U. S. Department of Agriculture, who is at present time located in Riverside studying the sugar beet leafhopper, and who has been doing considerable work on this insect for several years to read the paper which is entitled "Notes on the Behavior of the Beet Leafhopper."

Mr. C. F. Stahl: Dr. Severin has prepared two very interesting papers on the beet leafhopper, both of which throw new light upon this insect. The title of the first paper has already been announced and the subject matter follows:

NOTES ON THE BEHAVIOR OF THE BEET LEAFHOPPER (EUTETTIX TENELLA BAKER)

By Henry H. P. Severin, Ph.D., *California Agricultural Experiment Station*

Sexual Behavior

Dr. E. D. Ball[1] noticed a swarming of the beet leafhopper (*Eutettix tenella* Baker) "near Pauguitch, Utah, at an elevation of 7,000 feet, just at the time the immense swarms swept over the beet regions of Utah in 1915. They were first observed in the evening just as the sun was setting and at this time were flying around and hovering over a little patch of young pigweed"; this was interpreted as an evening rest while migrating. "The next morning they were there in numbers, but quite sluggish with the cold. When this patch was visited a little later they were gone and none could be found in the valley." This observation was made in a mountain valley "above the limit of beet raising and no doubt above the limit of their breeding range," and was located in the approach to a mountain pass leading over to the southern desert.

In California the writer saw apparently the same behavior at 130 feet below sea level in the Imperial Valley and frequently in the beet fields and also on the plains of the San Joaquin Valley. The behavior is associated with mating and was first studied at Heber in the Imperial Valley on June 3–9, 1918, where an enormous congregation of nymphs and adults had occurred on the Nettle Leaf Goosefoot (*Chenopodium*

[1] Ball, E. D., 1917. Utah Agr. Exp. Sta., Bul. 155, pp. 28–29.

murale) growing near dried *Atriplex elegans*. The different phases of the sexual behavior were observed through a reading glass having a diameter of six inches and a long focal distance.

During the week in which the sexual behavior was studied at Heber, the beet leafhoppers began to clean their bodies before sundown between 6.30 and 6.45 p. m. The wings were stroked and occasionally raised with the hind legs, the middle and front legs cleaning the rest of the body. Before sundown 20 adults were collected with a pipette while they were engaged in cleaning movements and of this number 12 were males and 8 were females. Even the nymphs were aroused to activity at sunset and cleaned their bodies.

On June 8, a partial eclipse of the sun caused a drop in the temperature but the cleaning reaction started at 6.30 p. m. Observations at Mount Wilson Observatory showed that the solar eclipse began at 2 minutes after 3 o'clock, and ended at 38 minutes after 5 o'clock. At the turning point, 4.21 o'clock, 74 per cent of the sun's surface was obscured.

After the male has cleaned his body he may rest for a time; he then walks forward a short distance at the same time fluttering his wings; he stops suddenly for an instant and moves forward again in the same manner and so on. During the week, 55 adults showing this behavior were captured with a pipette before sundown and all proved to be males. The males walked about on the stem, leaves and cluster of seeds and when one discovered a female he sidled up to her with wings elevated on one side of the body and endeavored to copulate. If the female is not inclined to mate, she may kick viciously with her hind legs at the male and if he persists in his attentions, she may walk or fly away. The male often takes short flights in seeking his mate. Sometimes a male may force his attention on a nymph and cause the latter to rear up the abdomen and kick with the hind legs or the nymph may walk or hop away.

After sundown on a calm evening, both male and female adults were aroused to an unusual activity and took short flights about the weed. Hundreds of leafhoppers on the wing swarmed about the plants. Many specimens came to rest on my clothes, face, hands and reading glass, but just for a few moments and then they took wing again. Twenty-three beet leafhoppers were taken on my clothes and of this number 18 were males and 5 were females.

After darkness had set in about 9 p. m. a light thrown on the Nettle Leaf Goosefoot with a flash light showed that the hoppers were at rest on the weed. During the nights of June 7–8, 49 specimens at rest were caught and of this number 25 were males and 24 were females.

The cleaning movements and sexual behavior were observed in sugar

beet fields at Le Grand on July 12, and at Manteca on August 31. At Le Grand the males took short flights from beet to beet or somewhat longer flights from 5–10 feet.

During the last week in October the sexual behavior was observed on the plains adjacent to about 50 square miles of Russian Thistles (*Salsola kali* var. *tenuifolia*) interspersed with patches of Fog Weeds (*Atriplex expansa*) growing in the vicinity of Oro Loma in the San Joaquin Valley. The plains extended about 3 miles to the foothills of the Coast Range and on both, the beet leafhoppers were captured on Red Stem Filaree (*Erodium cicutarium*) during the daytime. A quarter of an hour before the sun sank behind the mountains, an occasional adult was taken on the wing, but the number of flying specimens gradually increased after sundown (5.05 p. m.). The bugs did not orient themselves with reference to the light northwest wind but flew about in all directions. A person standing quietly on the plains soon became covered with hoppers but the insects seemed to be extremely restless, pausing for a short time and then taking wing again. The males flitted their wings in walking about but the females remained inactive. At one time 6 males circled around or sidled up to a female. At 5.15 the first pair in coition was taken and mating continued until dark. (See Plate 15.)

The windshield of an automobile attracted hundreds of beet leafhoppers after sundown and resembled the swarming of enormous numbers of insects around an electric arc lamp. An insect-net was moved back and forth in front of the windshield and the following proportion of male and female specimens were taken on the plains near Oro Loma on October 31:

Light males	Dark males	Light females	Dark females	Total
58	252	0	34	344
17%	73%		10%	

Does the sexual behavior occur at sunrise? Observations were made at sunrise during two mornings on the Nettle Leaf Goosefoot at Heber in the Imperial Valley. The mornings were cool and at sunrise the hoppers did not stir. An occasional specimen was noticed cleaning its body between 6–7 a. m. but no sexual activity was observed.

When beet leafhoppers were required from shrubby perennial Atriplex for experimental purposes, advantage was taken of the fact that the adults are aroused to activity at sunset and are taken more abundantly after sundown than during the daytime. One of many tests will be given. Two persons swept Cattle Spinach (*Atriplex polycarpa*) with an insect-net for an hour during the afternoon and the same shrubs were swept for half an hour after sundown with the following results:

Cattle Spinach, Four Miles South of Shafter, October 28, 1918

Light males	Dark males	Light females	Dark females	Total
2.40 to 3.40 p. m.				
12	0	3	9	24
5.15 to 5.45 p. m.				
56	4	5	61	126

In all probability, the hoppers remain within the shrubs during the daytime, and come to the outer branches and foliage at sunset.

During the summer a student was employed for a week to capture *E. tenella* on sugar beets and he caught as many leafhoppers after sunset when no heavy winds were blowing as he did during the entire day.

Nocturnal Habit

E. tenella is a nocturnal insect and displays a considerable amount of activity at night. Tanglefoot fly paper was fastened to barren sandy soil and on boards attached about two feet above the ground at 9 p. m. in the vicinity of the Nettle Leaf Goosefoot on which an enormous congregation of nymphs and adults had occurred at Heber in the Imperial Valley. The next morning before daylight adults were found adhering to the fly paper.

The nymphs also move about at night and seek new food plants when the vegetation on which they are feeding becomes dry. Strips of tanglefoot fly paper were fastened to the sand at night midway between a dried patch of Nettle Leaf Goosefoot and a half dozen green plants. The next morning at 4 a. m. 9 nymphs and 5 adults were found on the fly paper.

There is some evidence to show that the nymphs will leave green plants and wander about on the ground at night. Strips of tanglefoot fly paper were fastened to the sand at night on all sides of an isolated Nettle Leaf Goosefoot plant, at a distance of one yard from the terminal end of the branches. The next morning before daylight 12 nymphs and 4 adults were found sticking to the fly paper.

During the night large numbers of nymphs and adults left green Nettle Leaf Goosefoot plants and were found on the sand below the weeds before daylight on the next morning. When tanglefoot fly paper was fastened to the sand directly below the branches at night several hundred nymphs and numerous adults were found the next morning. Nymphs and adults, however, were also abundant on the stems, leaves and cluster of seeds of this weed at 4 a. m. Do the hoppers seek the warmth of the sand during the night?

Reaction to Heat

It is a well known fact that the larvæ of certain pests are killed when they come in contact with soil on hot days and hence several trials were made with nymphs of *E. tenella.* In one test 100 nymphs collected on the Nettle Leaf Goosefoot at Heber in the Imperial Valley were dropped on soil in a depression which had been irrigated and baked into a hard crust. When the insects came in contact with the hot ground they hopped about at a lively rate. A large specimen was followed and it soon became evident that the distance of each leap became shorter and shorter. Oftentimes the hopper fell on its back after a jump and experienced difficulty in righting itself. At the end of 20 minutes the creature was lying on its back and made no further effort to move. It had hopped 15 feet from the point of liberation. The experiment was repeated several times and in each case the nymph died. The thermometer registered 110° F. in the shade.

Phototaxis

On rare occasions the beet leafhopper is attracted to electric lamps. At Coalinga in the San Joaquin Valley, the adults were taken on a glass show case situated below a 200 watt "Daylight Lamp," on show windows and in bowls enclosing incandescent electric lamps fastened to the ceiling at the entrance of stores. The following figures give the proportion of sexes:

	Males	Females	Total
July 15/18	3	26	29
Aug. 3/18	21	113	134
	24	139	163
	14%	85%	

At Coalinga the adults showed a positive reaction to an auto spot light and left the Fog Weed and congregated on the soil illuminated by the lamp. When the spot light was held a few feet from the hoppers some of the specimens flew to the light. Similar results were obtained near Shafter on July 18.

In the Imperial Valley enormous numbers of Jassids were attracted to electric lamps in cantaloupe packing sheds on calm evenings. A single female beet leafhopper was captured at Heber on June 7, but not another specimen was taken from June 8–15.

Reaction to Shadow

When a person walked past a Nettle Leaf Goosefoot plant a swarm of adults flew up, some settled on the ground but most of them came to rest upon the weed. Before and after sunrise, however, the hoppers

did not respond, probably due to the lower temperatures. When a person stood perfectly quiet near a plant and a shadow was thrown on the weed, some of the leafhoppers immediately flew about. When an insect-net was moved about but without casting a shadow upon the plant, the bugs did not fly from the weed. Evidently the insects do not respond to a moving object but a shadow arouses some of them to activity.

Chairman H. J. Quayle: I see Prof. Doane is here now. We will listen to his paper on "Weevils in Australian Wheat in California."

WEEVILS IN AUSTRALIAN WHEAT IN CALIFORNIA

By R. W. Doane, *Stanford University, California. Collaborator, Bureau of Entomology, U. S. Department Agriculture*

The great demand for vessels of all kinds that came with the beginning of the late war soon interrupted the normal movement of foodstuffs in all parts of the world. In a very short time the serious results of this restricted movement began to be apparent in many quarters. Vast quantities of food that were badly needed elsewhere began to accumulate in certain centers where no provision was ever made to handle it in such unusual amounts.

One of the most serious situations brought about by this condition was the accumulation of millions of bushels of wheat in the Australian and New Zealand seaports, where most of it had to lay for many months; some for three or four years, awaiting shipment. It was inevitable that the weevils and other insects should take advantage of such an opportunity to wax fat and multiply.

I have not seen any account of the work that has been done in Australia in the efforts to control the weevils there, but I have had an opportunity to inspect much of the wheat that has come into San Francisco and Los Angeles from Australia, and to see the way in which the mills here handle the infested grain.

The wheat was imported by the Grain Corporation of the United States Food Commission, and sold to the mills that seemed to need it most. Most of it went to mills in San Francisco and Vallejo, but some went to Stockton and some to Los Angeles and vicinity, and smaller amounts to Oregon and Arizona. All of the mills receiving this wheat were working on government contracts, furnishing the government a certain amount of flour or other products. The Grain Corporation assumed no control over the wheat after it was taken from the docks by the mills.

The first few lots of this wheat came on some of the steamers that ply regularly between San Francisco and Australia. These steamers make the trip in about twenty days. Most of the wheat, however, has been shipped on sailing vessels requiring eighty or ninety days or more to make the trip. I am told that one vessel was at sea nearly six months before it finally reached San Francisco.

Of course these long trips, mostly through tropical waters, give time for the wheat to become thoroughly warmed. Unfortunately we did not take any temperature tests in the holds of these vessels, but several times it was found that the wheat in the sacks would feel very warm and this heat would be retained for several hours after the sacks were stacked on the docks. So the number of insects in these cargoes was doubtless much greater when the ships reached San Francisco than when they left Australia, as conditions were almost ideal for their development. But the great amount of wheat that had been cut by the weevils and the masses of insects that were found on and throughout the sacks that came on the steamers in the earlier shipments, showed that most of the damage must have been done while the wheat was still in storage in Australia.

There was a great deal of difference in the amount of infestation in the different sacks in all of the shipments. Some sacks showed but little injury due to the beetles, in other sacks we would find 80 per cent to 90 per cent of the grain injured or destroyed by the weevils. A handful of the grain taken from the sack would sometimes contain from six to fifteen or more weevils. These badly infested sacks were usually covered with the beetles that were coming from the wheat, and the flour or dust from the injured grains was sifting through the exit holes made by the beetles.

In San Francisco most of this wheat was hauled from the docks to the mills and carried by conveyers directly to the bins where it was stored until needed. Usually the miller began to draw on this supply at once, for few, if any, of the companies had any reserve. Before the wheat was stored in the bins it passed through screens to take out the straws, unthrashed heads and other large rubbish. As it was drawn off for use it passed through suction cleaners that drew off the light grain, weed seeds, weevils, etc. These screenings were placed in sacks and disposed of in various ways. If they contained a good deal of grain they were often sold for chicken or hog or sheep feed, or ground in the atrition mill for ground feed. Some of the lots that contained but little wheat and much smut and many beetles and weed seeds, were burned or thrown into the bay.

Although we all recognized that burning was the safest way to handle these screenings, it did not seem advisable to destroy the lots

that contained a considerable amount of wheat that might be used for feed, especially if we could in some way destroy the beetles so they would not be a source of danger wherever the feed was used.

Carbon bisulphide could not be used for this purpose as the mills would not take the fire risk. Cyanide seemed to be out of the question as the screenings were so finely packed in the sacks that it would be very hard, if not impossible, to get sufficient penetration of the gas, unless the vacuum system was used and that was considered too expensive for the purpose.

We urged that all of the mills that were handling this wheat make some provision for treating the screenings with heat to destroy the insects and some of them complied with this request. One firm, instead of building a small room or partitioning off a small part of a large room, constructed a tight box 16 feet long, 5 feet high and 3 feet from front to back. The front side of the box was provided with eight doors which opened practically the whole side of the box. These doors were secured by fasteners which clamped them close to their frames when closed. There was shelf room for 16 sacks of wheat in this box. Close to the bottom were 28, 9-foot lengths of 3/4-inch pipe. The cost of such a box including material and labor was about $200. The engineer said that the cost of operating it was inconsiderable as it took but little steam to maintain the required temperature.

The sacks of screenings to be treated were placed in this box about 9 o'clock in the morning and left there until 3 or 4 o'clock of the same day, sometimes they were left there until the next morning. The steam was turned on as soon as the box was filled and left until 4.30 or 5 o'clock in the evening.

An examination of the screenings that had been subjected to this treatment showed that, when the sacks were left in the box for only six or eight hours, all of the beetles were not killed, but when they were left in twelve hours or longer, no living insects could be found. A series of tests and experiments showed that with a steam pressure of 80 pounds the temperature in the box was raised to about 53° C. in a very short time; with an increased pressure the temperature rises very rapidly. With 150 pounds pressure the thermometer soon read 90° or 92° C.

The weevils and other beetles that were on the outside of the sacks began to die when the temperature reached 50° to 52° C. and before it reached 60° C. all that were exposed were dead. But it was found that the heat penetrates the screenings very slowly, so that after an exposure of six hours to a temperature of 53° to 80° C. a thermometer that had been placed in the center of the sack showed no increase of temperature. After about seven or eight hours the heat began to

reach the center of the sack and in about twelve or fourteen hours the temperature would go as high as 53° to 58° C. while the temperature in the box outside the sacks would be 80° to 90° C. Under these conditions all the insects in the screenings were killed.

The screenings after being taken from the hot-box gave up their heat, seemingly, as slowly as they took it, for we found that the temperature in one of the sacks dropped only 3° C. in five hours, although the sack was placed near an outside door in a cool store room.

The results of these experiments showed that with a box as described above and with a steam pressure of 80 to 150 pounds the screenings should be exposed to the heat twelve hours.

One of the Los Angeles mills built a small brick walled room about 6 feet by 10 feet by 8 feet high. It was heated by short coils of pipe on one side of the room 4 or 5 feet from the floor. The cost of building this room and installing the pipes was about $225. The miller said that it took several hours to heat the room and that he had found it necessary to raise the temperature to 190° F. (88° C.) in order to kill the insects. The thermometer from which his readings were taken was placed on the wall near the steam coils and on the same level with them. Tests made with other thermometers showed that one placed on a level with the coils but some distance from them, soon reached 71°C. Another placed about 2 feet from the floor, on a sack of screenings registered 48° C. while a third that had been thrust into the center of the sack of screenings registered only 28° C. This showed that the unusual and unsatisfactory results that were being obtained were due to the steam coils being placed high on the sides of the wall, instead of on the floor or very close to it. It is believed that when these coils are placed lower down, as recommended, no further trouble will be met with.

Some other mills have already installed, or propose to install, small heat rooms for treating infested flour or other material that may be returned to the mill from dealers or elsewhere.

One company has been spraying all of the Australian wheat received by its various mills with carbon tetrachloride. The work is done with small hand pumps and the wheat is sprayed as it is poured from the conveyers into the bins. The aim is to use about 2 gallons of the liquid to about 1000 bushels or 30 tons of the grain. In this way they figure that the cost of the material for treating a ton of grain is about 20 cents. If the bins in which wheat, that has been treated in this way, is stored, are tight and can be kept closed for a few days, nearly all of the weevils are killed. If the wheat is drawn from the bins within twenty-four or thirty-six hours after it has been treated, many live weevils are often found. The wheat should lie in the bin at least

two or three days to insure satisfactory results. This company reports that careful tests show that the milling qualities of wheat treated in this way are not affected.

The Rice Weevil, *Calandra oryzae*, is the most common beetle found in all of the shipments of Australian wheat, that I have examined. In some lots the grain weevil, *C. granaria*, was also very abundant, in other shipments but few were found. The saw-toothed grain beetles, *Silvanus surinamensis*, were always abundant. The confused flour beetles, *Tribolium confusum*, were common in all shipments, and *T. ferrugineum* was also often quite common. The lesser grain-borer, *Rhizopertha dominica*, was always quite abundant and apparently very destructive. The flat grain beetle, *Laemophloeus minutus*, was common in all lots. The cadelle, *Tenebroides mauritanicus*, and a few other beetles were more or less common.

Mesaporus calandrae How., the cosmopolitan parasite of grain weevils, was common on nearly all lots of Australian wheat examined and it was exceedingly abundant in some of the lots.

Chairman H. J. Quayle: There are a number of papers on file with the Secretary to be read. Inasmuch as the authors are not present to read these papers, I am going to ask the Secretary to read them by title only. They will be included in the proceedings and can be read by all of us at some future time.

INVESTIGATIONS OF THE BEET LEAFHOPPER (EUTETTIX TENELLA BAKER) IN CALIFORNIA

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I. Introduction

Where do the enormous numbers of beet leafhoppers (*Eutettix tenella* Baker), which invade the cultivated districts, come from in the spring? Where do the hoppers go in the autumn after leaving the cultivated area and where do they spend the winter? These are questions that have been asked repeatedly by agriculturists and have baffled scientists during the past thirteen years. Are there other plants from which the leafhoppers transmit curly leaf disease to sugar beets? These subjects and a consideration of the life history and related topics will receive attention.

In California, Dr. E. D. Ball (1), former director of the Utah Agricultural Experiment Station, endeavors to trace the origin of the pest in the beet fields through migrations from desert breeding areas in the

Death Valley, Mojave Desert, Imperial Valley, Tulare Lake and Bakersfield sections of the San Joaquin Valley.

II. Death Valley

We (3) have published the results of our investigations conducted in the Death Valley on January 27–31, 1918. At this time of the year no specimens were taken on desert vegetation from Ryan to Keane Wonder, a distance of 38 miles, and on vegetation growing in the cultivated districts at Furnace Creek ranch situated midway between the two towns.

III. Antelope Valley and Mojave Desert

During the winter and spring of 1918, trips were taken into the Antelope Valley and Mojave Desert to ascertain the abundance of the pest under desert and cultivated conditions and on vegetation growing along the Mojave River. During the winter the leafhopper was extremely scarce on desert vegetation in the Antelope Valley and Mojave Desert. In the vicinity of beet land, the adults were collected abundantly on desert vegetation during January but in March only a single specimen was captured on Rabbit Brush (*Chrysothamnus graveolens*) growing along the Mojave River. In the cultivated area of the Antelope Valley, the hoppers were commonly taken in piles of blighted sugar beets near Lancaster on January 7.

In the spring, plants of the Saltbush Family (Chenopodiaceæ) to which the sugar beet belongs, made their appearance in the cultivated area and on these enormous numbers of beet leafhoppers were present. The bugs were far more abundant on *Atriplex bracteosa* growing near beet fields than on the sugar beets. The insects were commonly taken on the Fog Weed (*Atriplex expansa*), *Atriplex rosea* and Russian Thistle (*Salsola kali* var. *tenuifolia*) growing along railroad tracks.

The results show that instead of a migration of *E. tenella* from the Mojave Desert, an invasion of enormous numbers into the cultivated area occurred between March 17 and June 12. The beet leafhoppers of the spring brood can usually be detected from the winter forms, the former are pale green or cream colored, whereas the latter are dark in color,—especially the females. A considerable amount of individual variation occurs in the color pattern.

IV. Imperial Valley

We (3) have published the results of our investigations carried on in the Imperial Valley during the winter of 1918, and a brief account of the work conducted in this region during the spring will now be given. The beet leafhopper was extremely scarce on desert plants and on

vegetation growing along rivers. In the cultivated area, the hoppers were commonly taken on the Australian Saltbush (*Atriplex semibaccata*), a perennial plant which remains green during the winter, and grows along irrigation canals, roadsides, railroad tracks, fences and in vacant fields. In all probability, many millions of leafhoppers occur on this plant in the Imperial Valley.

The bugs will leave green succulent plants without an apparent stimulus. On March 13–April 21, the pest was abundant on the Lowland Purslane (*Sesuvium sessile*) at Niland, but on June 10, the hoppers had left not only the dry plants but also the young succulent plants growing among the older ones. Sweepings from plants of the Saltbush and related families indicated that apparently a dissemination of the insects to these plants had occurred.

An enormous congregation of the beet leafhoppers occurred on *Atriplex elegans*, a short lived annual plant, which makes its appearance in the spring in the irrigated districts of the Imperial Valley. At Heber the plants were dry on June 3, and the insects had left the vegetation. An attempt was made to locate the bugs. As one walked past patches of Nettle Leaf Goosefoot (*Chenopodium murale*) growing among and near dried *A. elegans* a swarm of leafhoppers flew up. In localities where *A. elegans* was not present, the pest did not occur in large numbers on the Nettle Leaf Goosefoot.

It is not to be assumed, however, that when *A. elegans* becomes dry the insects always congregate in enormous numbers on green plants in the vicinity. A long narrow tract of *A. elegans* bounded on one side by desert vegetation and on the opposite side by a field of alfalfa was found about 2 miles southwest of Niland. W. W. Thomas states that he captured about 500 specimens in 25 sweeps of the insect-net on these plants on April 21. On June 10, the writer visited the locality and all of the plants were dry except in shady places under bushes. The hoppers had left the dried *A. elegans.* In the neighborhood of the dried vegetation not more than a dozen adults and nymphs were collected each time patches of Nettle Leaf Goosefoot were swept. A few *A. rosea* were growing among the dried plants and along roadsides but no bugs were taken from these. No beet leafhoppers were found on cultivated plants or weeds or on desert vegetation in the vicinity.

Two explanations may be given as to the origin of the enormous numbers of beet leafhoppers on *A. elegans* in the Imperial Valley. The hoppers may have congregated on *A. elegans* from plants growing in the cultivated area of the Imperial Valley, such as the Australian Saltbush and Lowland Purslane, or the pest may have invaded the cultivated area from other breeding grounds. During March, the dark winter adults were far more abundant than the pale green or

cream colored forms of the spring brood, but in April the pale green or cream colored insects greatly out-numbered the dark bugs. No attention has been given to the canyons, foothills and mountains surrounding the Imperial Valley.

In the Imperial Valley, *E. tenella* has been bred from the Lowland Purslane, Australian Saltbush, and *A. elegans*. During the winter and spring only 15 beet leafhoppers were taken on 7 species of desert plants, 3 of which were perennial Atriplex. In the cultivated area, the insects were collected on 17 species of plants, 6 of which belong to the Saltbush family. The pest was most abundant on different species of Atriplex and Chenopodium.

V. San Joaquin Valley

Natural Breeding Area

While the writer was engaged in a grasshopper survey of the state of California in the spring of 1917, large numbers of Jassids were sometimes found on the plains and foothills. Two trips were taken in the San Joaquin Valley, the first on April 23–May 7, and the second on May 21–28. A small paper bag was fastened in the bottom of the insect-net and the insects which were swept from the vegetation dropped into this bag. A few bags of these sweepings were examined by Mr. Thomas but no *E. tenella* were found and on account of other work the material was set aside for examination during the winter. Up to the present time 250 bags of sweepings collected in various localities on the plains and foothills of the San Joaquin Valley have been examined with the following results:

April 25/17. 12 miles south Los Banos, 1 dark female *E. tenella*.
April 25/17. 17 miles south Los Banos, 1 dark female *E. tenella*.

Mr. Thomas discovered large numbers of adults of *E. tenella* on pasture vegetation on the plains in the vicinity of Coalinga on May 9, and Professor R. E. Smith found nymphs commonly on stones in the warm sunshine. A trip was made to determine whether the pest was local or general on pasture vegetation throughout the San Joaquin Valley. On May 16–21, about 700 miles were covered in an automobile by W. J. Hartung, Thomas and the writer and from 1–50 leafhoppers were taken with about 25 sweeps of the insect-net on Red Stem Filaree (*Erodium cicutarium*) growing on the plains, canyons and foothills in various localities on the west side of the San Joaquin Valley.

G. T. Scott and Thomas found a congregation of the beet leafhopper on *Artiplex coronata* on June 22, growing among the Spiny Saltbushes (*Atriplex confertifolia*) at Helm. On this date the Filaree was dry with few exceptions at Coalinga and most of the hoppers taken were males.

On our next visit to Helm on July 16, *A. coronata* was dry and the insects had disappeared from the plants. After the pasture vegetation became dry, an occasional specimen was taken on green annual and perennial plants growing among the dried Filaree on the plains and foothills during the summer.

The beet leafhopper was bred in large numbers from Red Stem Filaree growing under natural conditions near Coalinga. The plants were collected on May 22, and the adults were reared on June 25, in the hothouse. *E. tenella* was taken on 20 species of plants growing on the plains and foothills, 5 of which belong to the Saltbush family. The insects were found most abundant on Red Stem Filaree.

Invasion of Beet Leafhopper in Cultivated Area

A brief account of the number of beet leafhoppers present in the cultivated area of the San Joaquin Valley up to the time of the invasion of the pest will be given.

Throughout the winter, the leafhopper was taken in small numbers by striking the foliage of blighted beets a few blows with the hand or by shaking the leaves. During the first three months of the year, dark colored specimens were captured on beets planted in December at Manteca by Hartung.

Professor Smith, Dr. E. Carsner and Thomas were unable to find a single beet leafhopper in the beet fields at Connor, Corcoran, Goshen Junction, Chowchilla and Manteca on April 7–11, but a small percentage of curly leaf was observed in the beet fields at Connor and Manteca. No hoppers were collected on green vegetation in the cultivated territory. Hartung and the writer found that 4 per cent of the beets planted in December were blighted at Manteca on April 22. On this same date no adults were caught but nymphs were found on diseased beets. From the evidence at hand, apparently no adults of *E. tenella* were present in the cultivated districts in the localities investigated by the various scientists on April 7–22.

On April 24–25, Hartung found large numbers of pale green or cream colored hoppers in the beet fields at Le Grand, where a few weeks previously no adults occurred. Pale green or cream colored specimens were taken on plants of the Saltbush and related families at Coalinga on May 9, but more abundantly on these plants in the cultivated regions on May 16–21.

After the invasion of the pest into the cultivated sections, the hoppers were far more abundant on different species of Atriplex than on any other plants of the Saltbush family. The vast area of Atriplex along railroad tracks, roadsides, fences, in grain, alfalfa and vacant fields, alkali sinks, near hay and straw stacks far exceeds the beet

acreage in the San Joaquin Valley. A conservative estimate of the number of leafhoppers in the beet fields in 1918, compared with the enormous numbers found on the Fog Weed, *A. rosea* and *A. bracteosa* in the San Joaquin Valley would be 1: 1000.

In the spring the beet leafhopper was found in enormous numbers on short-lived annual Atriplex, such as *A. cordulata* and *A. coronata*. At Volta, *A. cordulata* was growing in an alkali sink and when these plants became dry, the nymphs and adults probably moved to the Fog Weed also growing in the basin, and the same apparently was true in a sink at Cholame,—when *A. coronata* became dry the nymphs and adults probably congregated on the Fog Weed. In irrigated districts, the insects were commonly taken on *A. coronata* and *A. phyllostegia* during the middle of July, but when these plants bear seeds the hoppers gradually disappear. It was frequently noticed that when the stems of other species of plants became woody the bugs left, but this was not the case with the Fog Weed, *A. rosea* and *A. bracteosa*, the leafhoppers often remaining on these three species of plants until the leaves became dry.

The beet leafhopper was captured on 30 species of plants in the cultivated area, 18 of which belong to the Saltbush family. The pest was most abundant on different species of Atriplex.

E. tenella was bred from a large number of plants growing in the cultivated area of the San Joaquin Valley. The weeds were collected in vacant fields, stubble fields, beet fields, truck crop fields, along roadsides, railroad tracks, rivers, irrigation and drainage canals. About a dozen weeds of each common species were gathered at random and each species was placed in a large paper bag. In the hothouse the roots of the plants were put into a tumbler or jar of water and placed in a cage together with a potted sugar beet. The weeds and beet were watered daily through a hole in the cheese cloth on the top of the cage and then the hole was plugged with cotton. Caterpillars and spiders were removed from the cages. It is evident that the eggs were deposited in the vegetation under natural conditions, and by this method the females were not forced to oviposit in the plants. The insects were reared to the adult stage. Table I gives a list of plants in which the beet leafhopper deposited its eggs in the cultivated districts of the San Joaquin Valley.

Table I—Plants in Which Beet Leafhopper Deposited Eggs, in Cultivated Area of San Joaquin Valley

Name of plant	Locality plants collected	Date plants collected 1918	Date adults were bred 1918
Wire Grass (Polygonum aviculare)	Manteca, beet field	July 11	Aug. 13
Curly Dock	Connor, beet field	July 18	Aug. 27
(Rumex crispus)	6 miles southeast Manteca	Sept. 6	Oct. 18
Nitrophila occidentalis[1]	10 miles north Goshen Jct.	May 20	June 25
	Manteca, beet field	July 11	Aug. 8
	Le Grand, beet field	July 13	Aug. 26
Lamb's Quarters[1] (Chenopodium album)	Manteca, beet field	Aug. 12	Oct. 3
Nettle Leaf Goosefoot[1]	Coalinga	May 22	July 23
(Chenopodium murale)	Chowchilla	July 14	Aug. 18
	Volta	July 16	Aug. 15
	Connor, beet field	July 18	Aug. 27
Chenopodium leptophyllum[1]	Le Grand, beet field	July 13	Aug. 17
	Manteca, beet field	Aug. 12	Oct. 3
	5 miles southeast Manteca	Sept. 6	Nov. 1
Mexican Tea[1]	Manteca, beet field	July 11	Aug. 15
(Chenopodium ambrosioides)	Manteca, beet field	Aug. 12	Oct. 4
Atriplex rosea[1]	Chowchilla	May 21	June 25
	3 miles south Manteca	Sept. 16	Oct. 22
Atriplex phyllostegia[1]	12 miles west Wasco	May 19	July 8
	2 miles south Angiola	May 20	June 27
	4 miles west Corcoran	May 20	June 27
	Chowchilla, beet field	May 21	June 27
Atriplex coronata[1]	1 mile south Allensworth	May 20	June 27
	Chowchilla	July 14	Aug. 27
Fog Weed[1]	4 miles west Corcoran	May 20	June 27
(Atriplex expansa)	Manteca, beet field	Sept. 5	Oct. 22
Atriplex minuscula[1]	Earlimart	July 17	Aug. 17
Atriplex bracteosa[1]	Manteca, beet field	July 11	Aug. 18
	11 miles east Los Banos	July 14	Aug. 10
	Coalinga	July 16	Aug. 13
	Manteca, beet field	Sept. 5	Oct. 22
Australian Salt Bush[1] (Atriplex semibaccata)	2 miles west Wasco	May 20	July 1
Suaeda depressa var. erecta[1]	Manteca	Sept. 5	Oct. 22
Russian Thistle[1]	6 miles west Corcoran	May 20	June 26
(Salsola kali var. tenuifolia)	Chowchilla	July 14	Aug. 16
	Oro Loma	July 15	Aug. 15
	Manteca, beet field	Sept. 5	Oct. 22
Rough Pigweed (Amaranthus retroflexus)	Manteca, beet field	July 11	Aug. 15
Tumble Weed (Amaranthus graecizans)	Le Grand, beet field	July 13	Aug. 16
Amaranthus deflexus	Le Grand, beet field	July 13	Aug. 26
	Manteca, beet field	Sept. 5	Oct. 22
Indian Chickweed (Mollugo verticillata)	Manteca, beet field	Aug. 12	Oct. 3
Lowland Purslane	Connor	May 19	June 26
(Sesuvium sessile)	Connor, beet field	July 18	Aug. 27
Red Maids (Calandrinia caulescens var. menziesii)	Chowchilla, beet field	May 21	June 25
Charlock	Manteca, beet field	July 11	Aug. 16
(Brassica arvensis)	Manteca, beet field	Aug. 12	Oct. 3
	5 miles southeast Manteca	Sept. 6	Oct. 23

[1] Plants of the Saltbush Family (Chenopodiaceæ), to which the sugar beets belongs.

Stink Weed (Wislizenia refracta)	Chowchilla	July 14	Aug. 18
Spanish Clover (Lotus americanus)	Manteca, beet field	July 11	Aug. 15
Red Stem Filaree (Erodium cicutarium)	4 miles west Corcoran	May 20	June 25
	Chowchilla	May 21	June 25
	Coalinga	May 22	June 27
Cheese Weed (Malva parviflora)	Coalinga	May 22	June 27
Alkali Mallow (Sida hederacea)	Connor, beet field	July 18	Aug. 18
Chinese Pusley (Heliotropium curassavicum)	Manteca, beet field	July 11	Aug. 15
	Connor, beet field	July 18	Aug. 18
	Manteca, beet field	Sept. 5	Oct. 22
Tolguacha, Jimson Weed (Datura meteloides)	Manteca, beet field	July 11	Aug. 16
	Le Grand, beet field	July 13	Aug. 15
	Coalinga	July 16	Aug. 10
	7 miles southeast Manteca	Sept. 6	Oct. 18
May Weed (Anthemis cotula)	Coalinga	May 22	June 27
Common Spikeweed (Centromadia pungens)	Chowchilla	July 14	Aug. 27
Common Sunflower (Helianthus annuus)	Manteca, beet field	July 11	Aug. 16
	Le Grand, beet field	July 13	Aug. 15
Spiny Clothbur (Xanthium spinosum)	Manteca, beet field	Aug. 12	Oct. 3
	Manteca, beet field	Sept. 5	Oct. 23
	7 miles southeast Manteca	Sept. 6	Oct. 18
Horseweed (Erigeron canadensis)	Chowchilla	July 14	Aug. 26

Return Flight from Cultivated to Natural Breeding Area

As the food plants of *E. tenella* become dry in the cultivated area, the adults leave the vegetation. Our earliest record of the disappearance of enormous numbers of beet leafhoppers from the Fog Weed occurred between September 25 and October 10. The Fog Weed was growing in an alkali sink near Cholame, situated in a mountain pass between the San Joaquin and Salinas Valleys. The basin covered about ten square miles and was surrounded by mountains. No specimens were collected on green vegetation growing in and on the outskirts of the sink on Octoger 10. The two cotyledons of Filaree were just appearing above the surface of the soil in the washes of the foothills but no bugs were taken. If the leafhoppers left Cholame Valley, then the insects either flew over the mountains or followed the passes.

During the summer, trips were taken to the vicinity of Oro Loma, where enormous numbers of leafhoppers were present on about 50 square miles of Russian Thistles interspersed with patches of Fog Weeds. During the last week in October, the bugs were still abundant on green Fog Weeds and on small Russian Thistles with the tops of the plants dry and the lower portions green. An unusually large number of insects had congregated on the Australian Saltbush growing along the roadsides. The hoppers were common on Filaree growing below

the Russian Thistles. Adjacent to the western margin of this large area of weeds were the plains which extended about 3 miles to the foothills and on both, the adults were often taken on Filaree.

It is not to be assumed that the hoppers are found only on the foothills along the margin of the San Joaquin Valley. In crossing the Coast Range through the Altamont Pass, the adults were taken on Filaree growing on the foothills situated about 4 miles from the western margin of the San Joaquin Valley.

During the winter *E. tenella* was not found on foothills which were densely covered with green vegetation but the hoppers seek those hills which are sparsely covered with Filaree. As a general rule, the leafhoppers were taken on foothills which were exposed to the sunshine during the morning and afternoon. In all probability, the position of one hill to another with reference to sunshine determines the choice of location for the winter.

During the last three months of the year the beet leafhoppers were found on Filaree growing on the plains or foothills in the following localities on the west (Coast Range), south (Tehachapi Mts.) and east (Sierra Nevada Mts.) sides of the San Joaquin Valley:

Nov. 13	Foothills south and west of Tracy.
Dec. 10	Foothills 13 miles southwest of Tracy.
Dec. 24	Foothills 13 miles southwest of Tracy.
Oct. 25	Base of foothills, west of Dos Palos.
Oct. 25	Plains and foothills west of Oro Loma.
Oct. 28	Plains 7 miles north of Bakersfield.
Oct. 29	Plains 3–10 miles west of Lost Hills.
Oct. 30	Plains and foothills in the vicinity of Tejon Pass.
Dec. 13	Plains 21 miles south of Bakersfield.
Oct. 30	Plains and foothills east of Famosa to Bakersfield.

If we correlate the facts discovered in the natural and cultivated portions of the San Joaquin Valley, one would not hesitate to make the following statements: After the pasture vegetation became dry on the plains and foothills, the beet leafhoppers flew into the cultivated districts. During the summer an occasional specimen was taken on the various plants growing on the plains and foothills, showing that not all of the hoppers leave their natural breeding grounds. The invasion of the pest into the cultivated sections began on April 24, continued until May 21, and probably later. The gradual disappearance of the bugs in the cultivated regions during October corresponded with the reappearance of the insects under natural conditions. All of the adults do not leave the cultivated localities and last spring these caused 4 per cent of blighted beets at Manteca. Apparently no adults were present in the cultivated area from April 7–22, but nymphs were found

on curly leaf beets. In all probability, the females wintering over in the cultivated territory deposited their eggs and died, and the nymphs which were observed on April 22, hatched from these eggs.

When to Plant Beets

The fact that most of the beet leafhoppers leave the cultivated area in the autumn has an important bearing with reference to the time of planting beets. Sugar beet agriculturists are well aware of the fact that when beets are planted in November, December and January in the San Joaquin Valley, if weather conditions are favorable for planting early, a good crop can usually be obtained. The weather conditions are the determining factor with reference to planting from November to January. Last year no heavy rains fell in the San Joaquin Valley until February 22, and hence early planting was not practicable. The present rainy season started unusually early and heavy rains fell on September 11–13. The most serious objections to planting early are as follows: (1) the young beets are sometimes destroyed by frost necessitating replanting; (2) about 75 per cent of the beets planted in November, 50 per cent in December and 15 per cent in early January develop seed stalks which slightly reduces the sugar contents and furthermore, these beets are woody and difficult to slice.

In the Imperial Valley *E. tenella* was abundant on the Australian Saltbush during the winter. A similar observation was made on several acres of this perennial Atriplex growing near Wasco but 75 per cent of the specimens collected on December 10, and 82 per cent on February 16, proved to be males. Evidently the adults do not leave this plant in October and fly to the plains and foothills. The Australian Saltbush was introduced from Australia as a forage plant and birds are said to distribute the seeds. If this plant spreads to the beet districts there is a possibility that early planted beets may become badly blighted.

Do heavy rains kill the beet leafhopper? At Manteca $3\frac{3}{4}$ inches of rain fell before the return flight of the insects to the natural breeding grounds had commenced. In sugar beet fields, an occasional adult was observed with wings spread and partly embedded in the sandy soil below the leaves of blighted sugar beets. Dead specimens were found in the folds and below dried leaves. Dead hoppers partly embedded in the soil were also commonly taken below branches of *A. bracteosa* and in 40 minutes, 30 adults were collected. Evidently the creatures crawled below the branches to escape from the rain. Dead nymphs were rarely found but these were probably difficult to detect. An examination of the bugs under a binocular microscope showed that 50 per cent had been parasitized. The material was dry and could not

be dissected to determine whether the remaining 50 per cent were not weakened forms that had parasitic larvæ within their bodies. Insects at the end of their natural life often become sluggish and inactive and of all of the leafhoppers taken only one dark form of the winter brood was found.

VI. Plants from Which the Beet Leafhopper Transmitted Curly Leaf to Sugar Beets

Boncquet and Hartung (2) have shown that 100 leafhoppers collected on species of Artemisia and Atriplex in the Tulare Lake region of California and confined singly in cages on beet seedlings failed to produce curly leaf until they had fed on diseased beets. Smith and Boncquet (4) tested fully 2,000 insects taken on *Atriplex tularensis* and *Chenopodium album* in the Tulare Lake region on several hundred different sugar beet plants without the production of curly leaf in a single instance. The writer has confirmed this result with hoppers captured on different species of plants but adults and nymphs were frequently caught which produced the beet disease. The beet leafhoppers were taken in the natural breeding areas, cultivated districts and deserts. Table II, gives a list of plants on which specimens of *E. tenella* were collected and transmitted curly leaf to sugar beets.

Table II—Plants on Which Beet Leafhoppers were Collected and Transmitted Curly Leaf to Sugar Beets

Name of plant	Locality beet leafhoppers were collected	Number of adults or nymphs	Date E. tenella captured 1918
Atriplex elegans[1]	Niland	200 adults	Apr. 21
	Niland	25 nymphs	Apr. 21
	Calexico	300 adults	Apr. 2
Australian Saltbush (Atriplex semibaccata)[1]	2 miles west Wasco	12 adults	Dec. 14
Lowland Purslane (Sesuvium sessile)	Dixieland	7 adults	Mar. 13
Creosote Bush (Larrea divaricata)	Victorville (desert) 2–4 miles from beet fields	14 adults	Jan. 30
Red Stem Filaree	King City near beet field	3 adults	May 27
(Erodium cicutarium)	King City, foothills	3 nymphs	Nov. 28
	Bitterwater, base of foothills	100 adults	Oct. 13
	Foothills, 13 miles southwest	12 adults	Dec. 10
	Tracy	18 nymphs	Dec. 24
		25 adults	Dec. 24

Nonvirulent adults reared from eggs and kept on Black Mustard (*Brassica nigra*) failed to transmit curly leaf to sugar beets when allowed to feed previously on Creosote Bush (*Larrea divaricata*) obtained from the Mojave Desert and Imperial Valley. A nonvirulent leafhopper caused curly leaf of a sugar beet when allowed to feed pre-

[1] Plants of the Saltbush Family (Chenopodiaceæ) to which the sugar beet belongs.

viously on the Lowland Purslane collected at Niland but two nonvirulent specimens failed to produce the beet disease from the Lowland Purslane taken at Dixieland.

Bur Clover (*Medicago hispida*) showed curly leaf symptoms caused by about 300 beet leafhoppers collected on Filaree, Bur Clover and Grass at the base of a foothill at Bitterwater on October 13. The three leaflets were folded along the sinuous distortions of the mid-rib and the transparent venation was evident on the youngest leaves. The hoppers were confined in a cage enclosing Bur Clover and the insects did not feed previously on curly leaf beets in the laboratory. After the curly leaf symptoms appeared on Bur Clover, some of the bugs were transferred to a sugar beet which also later became blighted.

The leafhoppers which hatched from eggs deposited in certain plants collected in the cultivated area of the Imperial, San Joaquin, Sacramento and Salinas Valleys sometimes caused curly leaf of sugar beets. The weeds usually became dry in the cages in a week or two and the nymphs probably were forced to feed on the beets in the later stages of their life history. Table III, gives a list of plants from which the hoppers were bred and transmitted curly leaf to sugar beets.

Table III—Plants from Which Beet Leafhopper was Bred and Transmitted Curly Leaf to Sugar Beets

Name of plant	Locality plants collected	Date plants collected 1918	Date adults were bred 1918
Atriplex rosea[1]	3 miles south Manteca	Sept. 16	Oct. 22
Fog Weed[1] (Atriplex expansa)	Manteca, beet field	Sept. 5	Oct. 22
Atriplex bracteosa[1]	11 miles east Los Banos	July 14	Aug. 16
	Coalinga	July 16	Aug. 13
	Manteca, beet field	Sept. 5	Oct. 22
Russian Thistle[1]	Chowchilla	July 14	Aug. 16
(Salsola kali var. tenuifolia)	Oro Loma	July 15	Aug. 15
	Manteca, beet field	Sept. 5	Oct. 22
Rough Pigweed	Manteca, beet field	July 11	Aug. 15
(Amaranthus retroflexus)	King City, beet field	July 31	Oct. 2
	Hamilton City, beet field	Aug. 22	Oct. 19
Tumble Weed	King City, beet field	July 4	Aug. 5
(Amaranthus græcizans)	Le Grand, beet field	July 13	Aug. 16
Amaranthus deflexus	Manteca, beet field	Sept. 5	Oct. 22
Lowland Purslane (Sesuvium sessile)	Niland	Apr. 7	June 3
Charlock (Brassica arvensis)	Hamilton City, beet field	Aug. 22	Oct. 5
Black Nightshade (Solanum nigrum var. douglasii)	King City, beet field	July 4	Aug. 5

If nonvirulent beet leafhoppers are not able to produce curly leaf *directly* or *indirectly* by the action of a secretion poured from their mouth-parts into the beet plant, it may be possible that a cycle of

[1] Plants of the Saltbush Family (Chenopodiaceæ) to which the sugar beet belongs.

plants harbor the disease; on the one hand, the table beets, mangel wurzel or stock beets, sugar beets, swiss chard or sea kale beets and the weeds listed in Table III, growing in the cultivated territory and on the other hand, Red Stem Filaree and possibly Bur Clover in the natural breeding area. Those adults that fed on blighted varieties of beets and weeds which harbor the disease in the cultivated districts transmitted the disease to Filaree after their return flight to the natural breeding area and those nymphs which have already hatched from eggs deposited in this Filaree became virulent. After the invasion of the pale green adults of the spring brood into the cultivated sections the disease is again transmitted to different varieties of beets and such weeds as can harbor the disease. The disease would then be carried over during late spring, summer and early autumn (April to October) in plants growing in the cultivated regions and in late autumn, winter and early spring (November to April) in plants growing on the plains and foothills.

VII. Life History

A brief account of the life history of *E. tenella* under Berkeley conditions will be given. The egg period was determined during each month from February to September and varied from 16–38 days under field conditions. In one experiment dark adults obtained from King City were kept in a cage over winter at Berkeley. The first nymphs hatched on April 15. The first adult was bred on May 15, requiring 30 days to complete the nymphal instars. Twenty-two adults were reared between May 15–June 27. On September 10, the nymphs of the second brood began to hatch, the adults having died previous to this date. The first and only adult of the second brood was found in the cage on October 21.

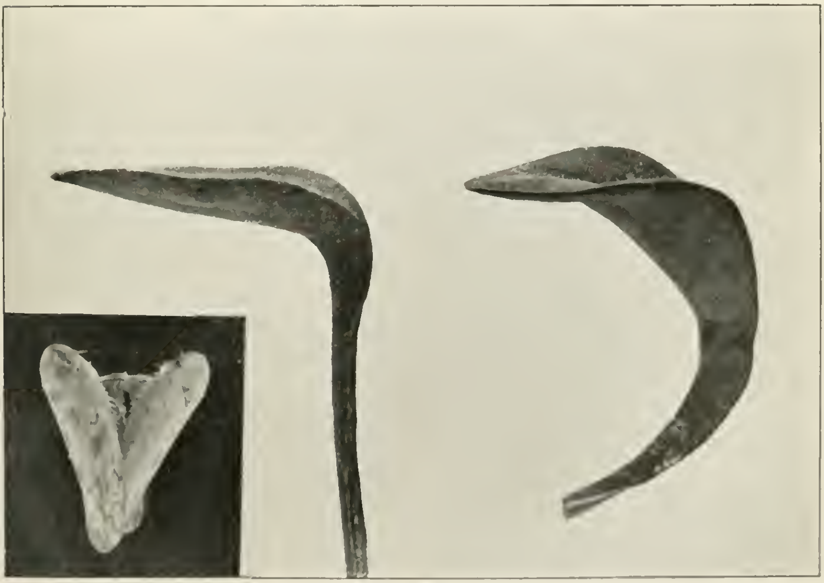
In another experiment 12 adults of the first generation were reared on June 17–July 4, from eggs deposited on March 14. The adults of the second brood were bred on November 5–15.

An interesting observation worthy of mention, is the fact that of several thousand beet leafhoppers which were reared out-of-doors at Berkeley, not a single pale green or cream colored adult was bred, every specimen without exception being dark.

Dark and Light Colored Adults

The first dark beet leafhoppers of the winter brood were captured in a beet field at Manteca on September 1. When the dark forms first make their appearance in the cultivated regions it is often difficult to detect dark males but in the natural breeding area these are easily identified during the winter. Dark females can be determined with

Sugar beet leaves in which Euteltex tenella deposited its eggs. The tissue was killed by the ovipositor and in the further growth of the plants the leaves become bent. (Original.)



Sugar beet leaves showing the above bent leaves; in insert a pair of leaf hoppers, mating, enlarged. (Original.)

certainty under both cultivated and natural conditions during the autumn and winter.

During September the dark adults gradually increased from 7–44 per cent. Before the return flight to the natural breeding area 86–98 per cent of the beet leafhoppers were dark and in December 90–98 per cent of the stragglers which remained behind in the cultivated regions were dark. In the natural breeding area 92–100 per cent of the leafhoppers were dark from October to December.

Do the yellowish beet leafhoppers assume the dark shades during autumn or winter? On September 5, 150 cream colored adults were captured in a beet field at Manteca, and were placed in a cage enclosing a sugar beet under field conditions at Berkeley. The hoppers were transferred to a new beet on November 8, and it was found that 75 had died. On December 19, the insects were again transferred and only 6 light forms survived and these were still alive in January. Evidently most of the light forms were near the end of their natural life and only a small percentage wintered over, possibly only those of the preceding generation which reached the adult stage late.

Do the nymphs in late summer, autumn and winter give rise to light adults? On September 5, 200 nymphs were captured in a beet field at Manteca and were placed in a cage enclosing a sugar beet under field conditions, and a similar experiment was conducted at Berkeley. The adults reared were all dark. In November and December nymphs were collected on the foothills and all of the adults bred were dark.

Incomplete Hibernation

E. tenella does not undergo a complete hibernation in the San Joaquin Valley, understanding by that term the passing of the winter in a torpid state without food. The bugs are torpid during cold weather, but when the sun warms the foothills during the winter, they become active. On cold days the hoppers were rarely captured in an insect-net; such specimens as were caught, sometimes displayed a torpid condition and could be rolled about in a net without showing a trace of life. When the leafhoppers were not taken by sweeping with a net, the adults were often collected by moving the hand among the Filaree, and the disturbance would sometimes cause them to make short leaps.

Experiments were conducted to determine whether the leafhoppers require food during the winter. The hoppers were captured on the foothills and were placed in cages without food. To prevent seeds from germinating within the cages, a hole was dug in the soil and filled with about six inches of moist sand. In one cage stones and blocks of wood were placed to shelter the insects from rains. The results obtained during November and December are indicated in Table IV:

Table IV—Number of Days Beet Leafhopper Lived Without Food During Winter

Date E. tenella began fast	Number of E. tenella	Date last E. tenella died	Number of days fasted	Mean maximum temperature	Mean minimum temperature	Precipitation
Nov. 22	60 adults	Dec. 1	9	57.6	36.7	1.06
Dec. 11	30 nymphs	Dec. 19	8	50.9	32.7	
Dec. 11	50 adults	Jan. 7	27	53.2	28.9	.46
Dec. 11	50 adults	Jan. 9	29	53.5	26.6	.53

Acknowledgements

The writer is deeply indebted to Mr. W. J. Hartung, agriculturist of the Spreckels Sugar Company, for data furnished and credited to him in this paper, and numerous courtesies extended during the work. Mr. W. W. Thomas, plant pathologist of the same company, accompanied the writer on most of the trips until he was called into the United States Army on August 7. The writer is under special obligations to Mr. S. P. Parish and to various members of the botanical department of the University of California for the determination of the plants mentioned in this paper.

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BIOLOGICAL NOTES ON THE FLATHEADED APPLE TREE BORER (CHRYSOBOTHRIS FEMORATA FAB.) AND THE PACIFIC FLATHEADED APPLE TREE BORER (CHRYSOBOTHRIS MALI HORN)

By H. E. Burke, *Specialist in Forest Entomology, Forest Insect Investigations, Bureau of Entomology, U. S. Department of Agriculture*

Practically every article written in America on apple insects or even general fruit insects mentions *Chrysobothris femorata* as an injurious enemy of the apple and other fruit and shade trees. Very few, however, ever mention *mali* which according to our records is far more common and injurious in the Pacific states than *femorata*. Numerous rearings have given us *femorata* from the prune and plum a few times and *mali* from the currant, apple, plum, prune, cherry, peach and

apricot a number of times. *Mali* is also more common in shade trees and brush forests while *femorata* is commoner in the oaks and the aspen forests of the high Sierras. *Femorata* occurs throughout the United States and *mali* has been reported from Oregon, California, Nevada, Utah, Colorado and Arizona. Many of the published records of damage by *femorata* in the Rocky Mountains and Pacific states undoubtedly refer to damage by *mali*.

Both species often cause severe damage to shade trees as the following western records will show. In 1912 the writer found a number of lombardy poplar trees in the High School grounds at Yreka, California, severely injured by the larval mines of *femorata*. In 1915 Mr. Josef Brunner reported the same species destructive to small black cottonwood at Missoula, Montana. The next year Mr. W. D. Edmonston found about half of the silver maple shade trees, planted in 1913 in Colorado Springs, killed by this species and Mr. F. C. Bishoff reported serious injury to planted sycamores at Dallas, Texas. An examination of a nursery near San Jose, California, in July, 1918, showed that out of a block of 1,500 European sycamores, 2–2½ inches in diameter, 258 were already dead from an attack by *mali*, many more were infested and partially girdled and numerous others were being infested by the young larvæ. A row of 47 white flowering horse chestnuts had 4 trees killed and 17 rendered unsaleable and some young beech were in the same condition. About the same time a forty acre field of red currants near Haywards, California, was found so badly infested by this same species that the owner expected to root up the entire lot and burn them. Planted maple, mountain ash, flowering cherry, loquat, beech and birch in and around Los Gatos and San Jose are heavily infested and many trees are killed outright. Both species attack and kill the eucalyptus and appear to be becoming destructive especially in the large planted groves.

Femorata and *mali* resemble each other closely in habits, seasonal history and character of work. The first evidences of an attack are wet spots on the bark. Later, in some plants as the cherry, plum and prune there is a strong flow of gum. In all cases the bark is apt to crack and show the frass filled mines beneath.

The eggs are flattened, oval, light colored, ribbed, about 1mm. (1/25 in.) in diameter. They are laid singly, sometimes close together, on the bark during June and July. Some are laid directly on the exposed surface of the bark but most are flattened down into depressions, tucked into crevices or inserted under loose flakes or between the scales. In hatching the young larva bores through the bottom of the shell directly into the bark. It soon mines down to the wood and winds back and forth through the outer wood and inner bark

until full grown, when it forms the pupal cell in the outer wood or middle bark. Full grown larvæ of *femorata* are about $\frac{3}{4}$ of an inch long, those of *mali* about $\frac{1}{2}$ inch. Feeding larvæ of *femorata* have been found under the bark from July 7 to June 10, prepupal larvæ in the pupal cells from August 22 to June 10; feeding larvæ of *mali* from July 19 to May 21 and prepupal larvæ from August 24 to July 19. The observations indicate that in California the most of both species pass the winter as prepupal larvæ in the cells. Some will pass two winters in this stage. *Femorata* has been taken a number of times in pupal cells in the bark but *mali* has always been in the wood. In the writers opinion the only reason for this is that *mali* seldom occurs where the bark is thick enough to form a pupal cell. *Femorata* pupæ were found from January 15 to September 10, *mali* pupæ from March 27 to June 19. The pupal stage lasts from two weeks to two months depending on the climatic conditions. The transformation to the beetle takes place in the pupal cell. Young *femorata* beetles have been found in the cells from March 28 to August 9, *mali* beetles from April 16 to August 7. The beetles usually pass from one to several weeks in the cells. They then emerge by an oval exit hole through the bark and are found crawling or resting on the leaves or bark of the host plant or flying about in the warm sunshine.

Femorata beetles have been taken in the field from May 15 to August 11, *mali* beetles from April 24 to August 7.

In the beetle stage the two species are easily told apart. The prosternum of *femorata* is straight across in front; that of *mali* has a short lobe. The anterior tibiæ of the *femorata* male has a number of small teeth on their inner margins, those of *mali* are abruptly dilated at the apical fourth. The larvæ are more difficult and it is a question if they can be distinguished in all cases. As a usual thing the *femorata* prepupal larvæ are larger than those of *mali*, the V on the dorsal plate of the first thoracic segment extends entirely through the rugosa area, the ventral groove is broader and deeper and the rugosities themselves are rounder, larger and more distinct.

Besides the typical *mali* there is another form which runs to *mali* in Horn's table. This may be the variety *lineatipennis*, Van Dyke. If so it should be raised to specific standing. It lives in the chaparral broom (*Baccharis pilularis*) in California and *B. sergiloides* in Arizona and does not occur in the same hosts with *mali*.

The recorded food plants of *femorata* include apple, quince, pear, peach, plum, apricot, cherry, currant and pecan among the orchard trees and oak, mountain ash, maple, beech, box elder, hickory, chestnut, sycamore, horse chestnut, linden, willow and redbud among the shade and forest trees. The records in the Branch of Forest Insect

Investigations give the black walnut (*Juglans nigra*), hickory (*Hicoria* sp.), chestnut (*Castanea dentata*), white oak (*Quercus alba*), chestnut oak (*Q. prinus*), hackberry (*Celtis occidentalis*), sweet gum (*Liquidambar styraciflua*), peach (*Prunus persica*), Texas redbud (*Cercis reniformis*) and maple (*Acer* sp.). In the west we have reared it from the smooth leafed willow (*Salix lævigata*), arroyo willow (*S. lasiolepis*), aspen (*Populus tremuloides*), black cottonwood (*P. trichocarpa*), Fremont cottonwood (*P. fremontii*), lombardy poplar (*P. nigra-italica*), white alder (*Alnus rhombifolia*), California white or valley oak (*Quercus lobata*), gambel oak (*Q. gambelii*), California live oak (*Q. agrifolia*), interior live oak (*Q. wislizeni*), California black oak (*Q. californica*), wild plum, (*Prunus americana*), domestic plum, prune (*P. domestica*), peach (*P. persica*), silver maple (*Acer saccharinum*) and blue gum (*Eucalyptus globulus*) and have taken larvæ which appear to be this species from the Carolina poplar (*P. deltoides*) European white birch (*Betula alba*) and blue oak (*P. douglassii*).

The recorded food plants of *mali* are the apple and the currant. We have reared the adults from the arroyo willow (*S. lasiolepis*), copper beech (*Fagus sylvatica purpurea*), California live oak (*Quercus agrifolia*), American elm (*Ulmus americana*), camperdown elm (*U. scabra pendula*), huntingdon elm (*U. scabra huntingdoni*), European sycamore (*Platanus orientalis*), California sycamore (*P. racemosa*), cultivated currant (*Ribes rubrum*), cultivated rose (*Rosa* sp.), mountain mahogany (*Cercocarpus parvifolius*), apple (*Pyrus malus*), European mountain ash (*Sorbus aucuparia*), Christmas berry (*Heteromeles arbutifolia*), plum, prune (*Prunus domestica*), Pacific plum (*P. subcordata*), Japanese weeping rose flowering cherry (*P. pendula*), cherry (*P. avium*), hollyleaf cherry (*P. ilicifolia*), peach (*P. persica*), apricot (*P. armeniaca*), loquat (*Eriobotraya japonica*), pea chaparral (*Pickeringia montana*), sycamore maple (*Acer pseudo-platanus*), silver maple (*A. saccharinum*), red maple (*A. rubrum*), Oregon maple (*A. macrophyllum*,) box elder (*A. negundo*), European horse chestnut (*Aesculus hippocastanam*), coffee berry (*Rhamnus california*), wild lilac (*Ceanothus soredIatus*), blue gum (*Eucalyptus globulus*) and madrone (*Arbutus menziesii*) and have taken larvæ which appear to be this species from the smooth leaf willow (*Salix lævigata*), weeping willow (*S. babylonica*), lombardy poplar (*Populus nigra-italica*), white alder (*Alnus rhombifolia*), California black oak (*Quercus california*), indian plum or oso berry (*Osmaronia cerasiformis*), evergreen buckthorn (*Rhamnus crocea*) and manzanita (*Arctostaphylos tomentosa*).

As both of these insects are produced in numbers from a great variety of native and introduced food plants practical control is rather difficult. Trees and shrubs should be well cultivated and kept in as

vigorous a condition as possible. This will not prevent an attack but it will help the plant to overcome it. Most attacks in California and the southwest start from what appears to be sunburns. Most of the smaller fruit and shade trees are attacked on the trunk. Weeping trees are attacked on the topmost branches which the leaves do not cover. Any kind of a protection which will keep the sun from reaching the exposed bark is good. Once the plant is infested, as is indicated by the wet spots on the bark, the best thing to do is to carefully cut away the dead bark, kill the borer and cover the wound with a good dressing such as coal tar or liquid asphalt.

LAC-PRODUCING INSECTS IN THE UNITED STATES (HEMIPTERA; COCCIDÆ)

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Lac (better known as "shellac") is an insect product. It is formed as a secretion from the dermal glands of certain species of Coccidæ belonging to the genus *Tachardia.* Species of this genus occur in Asia, Africa, Australia and North and South America, but at the present time only certain species found in Asia are utilized commercially. Lac is a very important article of commerce, being used as a basis for varnishes, as an insulating material in the electrical industry and for other minor purposes.

In view of the conditions existing during the late war it seemed that the possibility of developing a domestic source of supply of this substance should not be neglected. While it was fully realized that this possibility was remote, there were some grounds for believing that it existed.

We have three or four species of the genus *Tachardia* in the southwestern part of the United States. One of these species, *Tachardia larreæ* (Comstock), occurs in sufficient abundance to have attracted a considerable amount of attention and it has several times been suggested that the commercial recovery of the lac might be possible. Some encouragement has been lent to this belief by the fact that the host of this species is one of the most abundant and most widely distributed shrubs of the so-called "desert regions" of the United States. This plant is the "creosote bush," formerly known as *Larrea mexicana,* now called *Covillea glutinosa.*

Some of the reasons for believing that the matter was worthy of investigation may briefly be summarized.

Before the insect in question had received a scientific name, Dr. J. M. Stillman, later head of the Department of Chemistry of Stanford

University, had investigated it to some extent and had published several short articles concerning it. In one of these papers[1] he records the results of an examination of the lac and states: "It will thus be seen how closely the gum lac from Arizona agrees in characteristic properties, structure and chemical composition with the India varieties." In the same paper he states: "From observations by a number of gentlemen acquainted with that portion of the country, it appears that the Larrea lac is very widely distributed throughout Arizona and the southern part of California (Mohave and Colorado deserts), and the gum is used by the inhabitants in place of solder for mending kettles."

Professor J. H. Comstock[2] states: "Another true lac insect occurs in Arizona upon the stems and branches of *Larrea mexicana*. Judging from the specimens in the Museum of this department, the lac occurs upon this plant in sufficient quantity to be of economic importance."

In 1889 C. V. Riley[3] reports that a correspondent residing at Tucson, Arizona, wrote as follows concerning this lac: "I am led to believe that these exudations, if properly examined, would give a splendid bright red coloring matter and a very superior varnish resembling the celebrated Japan Lacquer. . . . I should think that a man could gather from 60 to 100 pounds of clear exudation matter in a working day of ten hours."

In 1897, Dr. L. O. Howard wrote[4]: "We have, however, in the southwest, on the very abundant creosote bush, a lac insect occurring in enormous quantity, the commercial possibilities of which have not been developed."

As there appeared to be no record that any thorough investigation of this matter had ever been made the writer called the attention of the Committee on Agriculture, Botany and Zoölogy of the National Research Council to it. This committee considered it a fit subject for an investigation and agreed to supply the relatively small sum necessary to permit the writer to carry this out.

I may state, without further delay, that the results of this investigation were entirely unfavorable. However, the information obtained should be recorded.

The first thing to be determined was the distribution and abundance of the insect. Taking into consideration the nature of the country in which the creosote bush occurs, it seemed that the investigation might

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[1] Stillman, J. M. American Chemical Journal, vol. 2, p. 4 (1880).

[2] Comstock, J. H. *In* Report United States Commissioner of Agriculture, p. 291 (1880).

[3] Riley, C. V. Insect Life, vol. 1, p. 345 (1889).

[4] Howard, L. O. Bull. 9, n. s., U. S. Dept. Agric., Div. Ent., p. 38 (1897).

most easily be conducted by traveling in an automobile. This belief was entirely justified. The creosote bush area was traversed twice, from California to New Mexico, and it is improbable that any very considerable area in which the scale insect might be found was overlooked. The adventures of an almost totally inexperienced driver in piloting an antiquated specimen of our most popular type of automobile over some hundreds of miles of desert roads that in large part consist of but a pair of wheel tracks through the brush were interesting in themselves but are not properly a part of this recital and may be left to the imagination.

Owing to the conspicuous appearance of the insect, its discovery, when it is present in any significant numbers, is a simple matter. Fairly accurate observations can in fact be made from a moving car. The lac occurs as a more or less solid incrustation on the twigs of the host plant, which is a very open shrub. The insects are extraordinarily gregarious and are almost never found singly, the colonies being from a quarter of an inch to a foot long. It appears that ordinarily the "crawlers" merely move out toward the tip of the twig, thus increasing the length of the colony.

The lac evidently remains upon the branches for a year and probably much longer for dead bushes were observed to which it was still clinging. Because of this it would seem reasonable to assume that occasionally plants would be found entirely covered by the insect. As a matter of fact nothing of the sort was ever seen, even in those localities where the insect is most abundant. In no case was a bush observed to have been killed by the scale and in but a few cases were more than two or three of the entire total of many feet of branches on a bush infested. It is this occurrence in closely massed colonies that causes an entirely fictitious appearance of abundance in museum specimens. Five inches of heavily incrusted twig in a bottle will call up pleasing visions of acres of bush thus infested—but this may have been the site of the only colony in an acre of creosote bush.

The insect was not encountered in New Mexico and I am informed by Professor Cockerell, who is more familiar with the scale insect fauna of New Mexico than is any one else, that he has never seen it there. Elsewhere it was found throughout the entire area traversed. It was first encountered near Palm Springs, California, and was present constantly along the road from Mecca to Glythe, thence to Yuma and from Yuma to Tucson by way of Ajo. It was not seen east of Tuscon but in returning it was encountered again at Rice, Arizona, and then from Phoenix to Parker it was relatively abundant. It was also present along the road from Parker to Needles and from Needles

to Barstow. The last specimens were seen at Inyokern, near the southern end of the Owens Valley in California.

In all of this area the present center of abundance is in the region bordering the Colorado River in the vicinity of Blythe and Parker. Here, from the standpoint of a collector, the insect is extraordinarily abundant. I estimated that from 10 to 20 per cent of the bushes were infested and the individual infestations were heavier than elsewhere. All other points I estimated that probably not more than 2 or 3 per cent of the bushes were infested at all.

Here, then, should be the points at which the commercial recovery of the lac should be possible, if it is possible at all. Attempts to gather a large quantity of the substance for experimental purposes soon showed the futility of any such hope. I seriously question that one could gather fifty pounds of well infested twigs in a day. Of this probably not more than a pound, if as much, would be lac. And lac *retails* at 75 cents a pound.

It is further to be noted that the area in which the insect is at present most abundant is quite limited, being confined to a narrow belt on each side of the Colorado River. Even were the insect sufficiently abundant in this region to make its gathering profitable the area thus favored is entirely too small to yield any very large supply.

Whether the insect could be artificially propagated is another question. To answer it would involve a long series of costly experiments that in all probability would likewise yield negative results.

INSECT PROBLEMS OF WESTERN SHADE TREES

By Frank B. Herbert, *Scientific Assistant,*[1] *Los Gatos, Cal.*

A forest insect laboratory was established at Los Gatos, California, in the fall of 1916, with Mr. H. E. Burke in charge, the object being to study the insect problems of shade trees and ornamental shrubs, with general instructions from the Washington office to first get acquainted with the local shade tree problems and then the larger problems of the Pacific Coast.

In this work and region a somewhat different class of insects is encountered from those found in the forest and most of them require very different methods of control. There are, of course, some wood and bark-borers which do considerable damage to shade trees, but by far the majority of the pests are scale insects.

[1] Branch of Forest Entomology, Bureau of Entomology, U. S. Department of Agriculture.

The host plants of importance here are quite different from those encountered in the forest. The pines and firs have been mostly replaced by a great variety of broad leaved deciduous and evergreen trees, some of which are natives, while the majority are gathered from various parts of the globe. With this importation of shade and ornamental trees have come some of our worst shade tree as well as fruit tree pests.

Probably a greater variety of insects is encountered on shade trees than on any other class of trees or plants. Many of the pests of deciduous fruits, nut, olive and citrus trees, berry vines, nurseries and greenhouses are met with, besides a large array which are peculiar to forest and shade trees only.

The harboring of pests on shade trees, which are also common to different kinds of fruit trees, causes an important relation between the two. This is particularly true in southern California, where a number of towns have spread out into the citrus districts, taking shade trees with them, and on many large estates the beautiful homes are surrounded by a wealth of trees and shrubs, which in turn are surrounded by citrus orchards. Fumigation and spraying are practiced in the orchards for the control of scale insects, but not to any large extent upon the shade trees, thus leaving a bountiful supply for reinfestation.

The Argentine ant is probably the main factor in transporting the scale insects from one tree to another, as well as protecting them from their parasites, and thus becoming a pest to be contended with in the control of shade tree pests. The ant is also a pest from another standpoint in that it thrives and multiplies upon the honeydew from scale insects infesting shade trees, and from here makes detested inroads into the pantries of nearby houses. This is a problem to be reckoned with especially during these days of food conservation.

Artificial control of insects on shade trees is greatly neglected. Most farmers now realize that such control is necessary for the maintenance of healthy fruit trees and the production of clean fruit. A great many people, however, believe that a shade tree should always be able to take care of itself. Therefore, one of the problems is to educate the people into seeing that spraying is necessary at times to maintain a healthy and vigorous shade tree.

If trees and shrubbery were placed farther apart, and if each individual tree were thinned out in the top a bit, not the way the tops are often slashed by telephone linemen, but by proper cutting, thus letting in the sunshine, much of the need of spraying would be obviated. This has been demonstrated in Pasadena. There the pepper trees were badly infested with black scale until they were systematically opened up to the sun, whereupon very little spraying became necessary and that only about the lower part of some of the trees.

Many shade trees become so large that the question of spraying is not an easy one. A high power spraying apparatus of good capacity has been found practicable for such trees, but this is not always available. Fumigation is often the most satisfactory method of controlling certain pests, but again, due to the large size of many trees and the lack of apparatus in all localities outside of the citrus districts, this becomes almost impossible.

There is not a great deal known here about the proper sprays to use upon conifers and evergreens. What such trees will stand in summer or winter is not very definitely known. This is one of the problems we are working on and hope to solve.

Washing trees off with a solid stream of water is known to be one of the best remedies for removing many soft bodied scale insects. This is the most feasible means for controlling the European elm scale, particularly on large elms wherever a good pressure of water is available. At least fifty pounds pressure is necessary to give the water enough force to remove the insects. Even with this pressure one needs a travelling platform and an eight or ten foot extension rod in order to get close enough to the scale insects to remove them. With a number of large trees and plenty of available water, it is advisable to use a fire engine and hose if possible, thus obtaining a large head of water under a pressure of 125 pounds or more, which is sufficient to reach all parts of the tree from the ground. One hundred and ninety large trees in San Jose were washed in this way with good success which was more economical than any spraying would have been.

Some people would rather let a shade tree die than to lift a finger to save it from its enemies, placing more value upon the tree for firewood than for any other purpose, while others would pay a great price to save a single tree, realizing that it would take many years to replace it. Thus the question of economy of control does not always enter into a problem.

The writer has specialized to some extent upon the scale insects infesting shade trees. Below are enumerated some of the more important of them.

The European elm scale, *Gossyparia spuria* (Linn.), mentioned above, is one of our worst pests, occurring in many localities of the west and becoming a disagreeable and harmful pest, causing the trees to become black and sticky, killing limbs and sometimes whole trees. Much of the honeydew falls on the ground, making the streets and sidewalks disagreeable and dangerous to passing horses.

The cypress bark scale, *Ehrhornia cupressi* (Ehrhorn), is a serious pest in central California upon some of our most popular shade trees.

The Monterey, Guadalupe, and Arizona cypresses and incense cedar are attacked, while the Italian and Oriental cypresses are immune. This is such a pest that it is even recommended that other trees be planted instead of these cypresses in badly infested regions.

The black scale, *Saissetia oleæ* (Bern.), is a pest of shade trees as well as fruit trees. In the interior regions it apparently does little harm, but in the San Francisco Bay Region it is a particularly harmful pest on oleanders and in southern California on pepper trees. It also infests a great many other native and foreign plants.

The mealy-bugs are quite a problem by themselves. The citrus mealy-bug, *Pseudococcus citri* (Risso), is almost entirely a southern California pest, as is also the long-tailed mealy-bug, *P. longispinus* (Targ.). In the rest of California these are mostly greenhouse pests. *P. maritimus* (Ehrh.) (*bakeri* Essig) is quite a cosmopolitan pest, occurring in a great many parts of the state and on a variety of host plants, including a number of shade trees.

P. gahani Green (*citrophilus* Clausen), known as a citrus pest of Southern California, is also a shade tree pest occurring on a number of trees. It has spread rather recently to central California, the writer having found it on black locust at Burlingame, and on Pittosporum, olive, fig, Poinsettia and rose at Oakland, California. It has also been previously reported from Niles, California.

The golden mealy-bug, *P. aurilanatus* (Mask.), is a very harmful pest upon Araucarias and Agathis in Southern California. *Araucaria bidwilli* seems to suffer the worst, with *A. excelsa* next and *A. imbricata* third. Many appear black and dilapidated, while numerous dead or dying trees are reported to have been removed.

The sycamore scale, *Stomacoccus platani* Ferris, although a newly described scale insect, apparently is quite widespread, infesting both the native sycamore and the European plane tree. The writer has already located it at Los Gatos, San Jose, Evergreen, Livermore, Fresno, Claremont and Pasadena, California. It was noticed doing considerable damage in several of these localities.

Some of the other important shade tree scale insects are: the Monterey pine scale, *Physokermes insignicola* (Craw.), which infests Monterey and other pines; *Toumeyella* sp., which infests the Austrian and Monterey pines; the California pine leaf scale, *Aspidiotus pini* Comstock (*californicus* Coleman), infesting most of the common pines; the cottony cushion scale, *Icerya purchasi* Mask., which does particular damage to boxwood and acacias; the rose scale, *Aulacaspis rosae* (Bouche), collecting in great numbers on the stems of roses, where it is quite conspicuous, occasionally doing some damage; the Italian pear scale, *Epidiaspis piricola* (Del Guercio), which does considerable

damage, particularly to the native toyon or Christmas berry; the San Jose scale, *Aspidiotus perniciosus* Comstock, and *Lecanium corni* Bouche which infest a number of trees, often doing damage.

Scale insects are by no means the only pests of shade trees. Indeed there are quite a number of other pests which are of prime importance, among which may be enumerated: the California oak worm, *Phryganidia californica* Pack., which spasmodically defoliates the oaks throughout the coast region of California; another defoliater, an oak worm looper, *Therina somniaria* Hulst., which is destructive to oak foliage in Oregon and farther north; the cypress bark-beetles, *Phloeosinus cupressi* Hopk. and *P. cristatus* Lec. which kill quite a number of cypresses yearly; the oak twig girdler, *Agrilus angelicus* Horn, which kills many oak twigs, sometimes injuring trees beyond recovery; the carpenter worm, *Prionoxystus robiniae* Peck, which injures oaks, elms and cottonwoods by honey-combing the bark and wood, the flat-headed borers, *Chrysobothris femorata*. Fab. and *C. mali* Horn, which destroy the cambium of a great variety of shade as well as fruit trees; a bark-beetle in oaks, *Pityophthorus pubipennis* Lec., and three in pines, *Dendroctonus valens* Lec., *Ips radiatae* Hopk. and *Ips plastographus* Lec. which at times are quite destructive.

Many other insects might be mentioned but these will serve to indicate our more important shade tree problems. Within the next few years it is hoped that we may be able to add considerably to the knowledge of western shade tree pests.

THE VALUE OF MOLASSES AND SYRUPS IN POISONED BAITS FOR GRASSHOPPERS AND CUTWORMS

By A. W. Morrill, *Phoenix, Ariz.*

During the summer of 1917, experiments were conducted with grasshopper baits which tended to show that molasses as an ingredient was unnecessary when used against the differential grasshopper (*Melanoplus differentialis*). A continuation of these experiments with grasshopper baits during 1918 and experiments with poisoned baits against cutworms has increased the evidence against molasses for the species of grasshoppers and cutworms under observation.

History of Poisoned Baits with Reference to Molasses

The experiments referred to have lead to an examination of the literature on the subject of grasshoppers and cutworm baits in order to determine the origin of the use of molasses in connection with such baits. Apparently the first published reference to poisoned bran

bait for grasshoppers is found in Bulletin 25 of the Division of Entomology published in 1891.[1] In this bulletin C. V. Riley quotes a letter from D. W. Coquillet concerning experiments with bran-arsenate mash in the San Joaquin Valley, California, in 1885. The formula which was used in California consisted of bran, arsenic, sugar and water. Coquillet emphatically stated that the use of sugar in the poisoned mash was not for the purpose of increasing the attractiveness to the grasshoppers but merely for the purpose of causing the arsenic to adhere to the flakes of bran.

The use of a poisoned bran bait against cutworms was apparently not discovered until 1894. The first published reference to such a bait for cutworms seems to be found in a paper by J. B. Smith read before the American Association of Economic Entomologists in August, 1894.[2] The combination used consisted of bran, Paris green and water which is said to have given absolute protection to sweet potato plants which were being severely attacked by cutworms. The first use of this habit is credited to a sweet potato grower named Oliver Parry, of Beverley, New Jersey. The addition of molasses or sugar to the plain poisoned bran mixture was recommended subsequently by J. B. Smith, the object being indicated as not for the purpose of increasing the attractiveness of the bait but for the purpose of making the particles of bran adhere together and better retain moisture.[3]

No doubt molasses was substituted for sugar to suit the convenience of the users of poisoned baits against grasshoppers in California during the late eighties, but the first published reference to such substitution appears to be one found in Insect Life.[4] Mr. H. B. Jackson, a correspondent of the Division of Entomology, living in Colorado, writing under date of August 15, 1892, referred to the successful use in Colorado against grasshoppers of a bait consisting of 100 parts of bran, 3 parts of Paris green "and some old molasses or other cheap sweet substance to make it stick together." In the same issue of Insect Life, Prof. Lawrence Bruner mentions bran and arsenic used in Colorado as a poisoned bait against grasshoppers, the absence of any mention of other ingredients indicating that the use of either sugar or molasses was not generally recognized as necessary.

In 1896 an important discovery was made by onion growers in New York state as reported by F. A. Sirrine in a bulletin of the New York

[1] Pp. 59–60.

[2] Insect Life, Vol. 7, No. 2, p. 191.

[3] Catalog Insects of New Jersey, p. 21, 1900. Bul. N. J. 169, Agr. Exp. Sta., pp. 11–12, 1903.

[4] Vol. 6, pp. 32–33.

Agricultural Experiment Station.[1] In work against the dark-sided cutworm (*Euxoa messoria*) it was found that dry bran and Paris green were as attractive to the cutworms as was moistened bran and remained effective over a longer period.

In recent years the recommendations of Sirrine seemed to have been largely overlooked by economic entomologists and it has become the rule to recommend the addition of molasses in poisoned baits for cutworms. Exceptions to this rule are noted however. Dr. S. A. Forbes, for instance, writing on corn pests in 1905,[2] following Sirrine's recommendations advised distributing with a seed drill dry bran or middlings poisoned by mixing in Paris green. Other writers have recommended salt instead of sugar or molasses. Dr. James Fletcher in 1901 quoted Mr. Norman Criddle[3] in regard to grasshopper baits, recommending one part of Paris green, one part of salt and 11 parts of bran.

The literature in regard to grasshopper and cutworm baits includes very little data which bears directly upon the value of molasses as an ingredient of such baits. Messrs. Hunter and Claassen in 1913[4] experimented with various poisoned mixtures including a series of bran and Paris green with and without syrups. Their results showed practically no difference between the plain bran and Paris green mixture and the bran-syrup Paris green mixture, a total of 329 hoppers being recorded at the first and 312 hoppers at the second. Prof. G. A. Dean, referring to experiments also conducted in Kansas in 1913 and previously,[5] stated in effect that glucose syrup was preferred over molasses.

In Canada, Mr. E. H. Strickland, after experiments with poisoned baits against two species of cutworms, the red-backed cutworm and the pale western cutworm, reported without presenting data that "true beet molasses gave the best results."[6]

A Russian Entomologist, B. Pukhov,[7] in his work against extensive grasshopper outbreaks in Russia (*Gomphocerus sibiricus* and other northern species of grasshoppers) found that wet bran in itself was very attractive to the insects but that "stale molasses" decreased its attractiveness.

The writer's experiments in 1917 were given in detail in a paper read

[1] Bul. 120, p. 194.

[2] Twenty-third Rep. State Ent. of Ill., p. 18, 1905.

[3] Rep. of Entomologist and Botanist in Ann. Rep. Exp. Farm for year 1900, pp. 206–207.

[4] Jour. Econ. Ent., Vol. 7, No. 1, p. 81.

[5] Jour. Econ. Ent., Vol. 7, No. 1, p. 82.

[6] Circ. 6, Ent. Branch Dept. Agr., Dom. Can., 1916.

[7] Agric. Gazette, Petrograd, 1917. See Rev. App. Ent., Vol. V, p. 355.

before the Association and published in 1918.[1] Working with the differential grasshopper no appreciable difference was observed between a series of baits with molasses and a similar series of baits without molasses, 2,115 of the insects being recorded at the first and 2,104 at the second series. Considering the baits in which citrus fruits were used the records seemed to show a decided decrease in the attractiveness in the bait when molasses (black strap) was included.

Messrs. J. J. Davis and C. F. Turner of the U. S. Department of Agriculture experimenting with the army worm (*Cirphis unipuncta*) secured practically 100 per cent efficiency from the use of bran and Paris green with water as needed. In another series of experiments conducted in a greenhouse which the authors considered as indicating "certain possibilities which should be tested in the fields" it was found that "there seems to be no noticeable difference in baits where molasses was used and where it was left out."[2]

Mr. D. A. Ricker has recently published records on the attractiveness of baits to three species of grasshoppers, *Melanoplus femur-rubrum*, *M. atlantis* and *M. bivittatus*. By combining his records to show the apparent effect of including molasses as an ingredient we find that in five combinations in which molasses was used 176 grasshoppers were recorded at the baits while in five corresponding combinations in which molasses was omitted 236 grasshoppers were recorded.

Information from Questionnaire

The responses to a questionnaire recently sent to the heads of state entomological departments showed that in the majority of states the Kansas formula for poisoned baits is recommended against both grasshoppers and cutworms. In a number of instances the fruit is not included in recommendations for baits against cutworms. The responses in only nine instances contain information directly relating to the matter of the value of molasses as an ingredient in poisoned baits. In some instances the greater efficiency claimed for baits including molasses or baits made with one kind of sweetening agent as compared with another was stated to be a general impression or at least not supported by definite experiments.

Mr. L. B. Smith, entomologist of the Virginia Truck Experiment Station, reported poor results against cutworms by omitting the molasses from baits when used for the protection of cauliflower, tomatoes, kohlrabi and peppers while no difference was observed on account of the omission of molasses in baits used for the protection of

[1] Jour. Econ. Ent., Vol. 11, No. 2, pp. 181–182, 1918.

[2] Can. Ent., Vol. L, No. 6, pp. 187–192, 1918.

cabbage, egg plants and beans. The species of cutworms under observation were *Agostis ypsilon, Peridroma saucia, Noctua clandestina, Feltia subgothica* and *Laphygma frugiperda.*

Prof. G. A. Dean, of Kansas, reported that unsatisfactory results believed to be due to the omission of molasses or syrup had been noted particularly in work against the variegated cutworm (*Peridroma margaritosa*) "at a time when so abundant as to take on the habits of the army worm." He also reported having observed no difference in results against grasshoppers with baits containing black strap molasses as compared with other grades of molasses or syrups. Professor Dean's results referred particularly to *Melanoplus differentialis, M. bivittatus* and *Peridroma margaritosa.*

Prof. M. H. Swenk, of Nebraska, reported the general impression that baits without sweetening were not as effective against grasshoppers as baits including sweetening. Karo or glucose syrups were considered as not as efficient as sorghum or cattle molasses, the last being preferred. This report from Nebraska referred to various species of *Melanoplus*, particularly *M. femur-rubrum* and *M. atlantis.*

Prof. R. A. Cooley, of Montana, reported black strap molasses in his experience as "much better than mild molasses or corn syrup." He had not, however, tested poisoned baits for grasshoppers or cutworms omitting sweetening agents of all kinds. His department recommends the use of molasses in cutworm bait at the rate of 1 pint to 25 pounds of bran whereas the Kansas formula, requiring four times as much molasses in proportion to the bran, is recommended against grasshoppers.

Prof. C. R. Jones, of Colorado, reported having used various grades of syrups and molasses without having noted any difference in results.

Observations in 1918 and 1919

In 1918, in experiments conducted on a large scale by the writer or under his direction in Arizona, six experiments gave results relating to the use of molasses as grasshopper bait (*M. differentialis*) and one relating to its use as a bait for cutworms (*Feltia annexa*). In four experiments in which molasses was omitted in one or more tests the results were as good as when molasses (black strap) was included. In one experiment in which the molasses was increased two-thirds over the usually recommended amount no effect could be detected. In one series in which a medium light grade of cooking molasses was used instead of the usually recommended darker grade, the results were almost perfect, tending to show independent of all other experiments, that a darker grade, particularly "black strap" is not necessary.

In the fall of 1918 a bait consisting of bran, Paris green and water

distributed broadcast in the same manner as baits are distributed for grasshoppers was tested against a common alfalfa pest, the granulated cutworm (*Feltia annexa* Tr.). The mixture consisted of one-half sack ($32\frac{1}{2}$ pounds) of bran, one pound of Paris green and water to give proper consistency for broadcasting. This was used at the rate of eight pounds (dry bran) to the acre. A hard rain fell during the night following the application of the first batch but a few days later in the portion of the field treated with this batch as well as in parts of the field where the applications were not followed by rain no live cutworms were found as a result of a search by the writer and two other observers with a total time of about 30 minutes. In a nearby field where no poison had been applied the cutworms remained in destructive numbers, no dead specimens being found.

Early in May of the present year a severe outbreak of variegated cutworms (*Lycophotia* (*Peridroma*) *saucia* Hbn.) occurred in alfalfa fields near Gilbert, Arizona. In one instance an eighty acre field was severely damaged, in fact all growth was prevented until the cause was discovered and the remedy applied. Poisoned bran mash made according to the formula used against the granulated cutworm a few months previous, was used by Dr. O. C. Bartlett, assistant state entomologist, with results which showed practically 100 per cent efficiency. Apparently only those worms which had ceased feeding in preparation for pupating escaped the effects of the poison.

Conclusions

At the present time it may be considered as established that molasses or syrup of any kind is absolutely unnecessary as an ingredient of poisoned baits against many of the common cutworms. On the other hand some investigators have found that the addition of molasses increases the attractiveness of the bait to some species under certain conditions. Evidence is accummulating to the effect that against some species of grasshoppers the use of molasses or syrup is an unnecessary expense. Owing to the differences reported from different sections it would not be safe to assume that the same ingredients will be found equally attractive to the same species of grasshoppers in different localities. Neverthless it would seem logical to accept the results of experiments with any one species in any locality until such time as similarly conclusive experiments in other localities have proven a variabilty in results. Whenever molasses or syrup can be omitted there is not only a material saving in the cost of the bait but the simplification of the directions for its preparation leads to the more ready adoption of control measures by the farmers. While the value

of the several ingredients in baits for use against grasshoppers is still a matter for investigation it seems most logical for entomologists to recommend the simple bran and Paris green or bran-Paris green and water mixture against cutworms except when there is some definite reason for the addition of molasses, syrups or other ingredients.

EFFECT OF EXCESSIVE STERILIZATION MEASURES ON THE GERMINATION OF SEEDS

By E. R. de Ong

Reports of fumigation injury to the germinating power of seeds are frequently based on a single piece of work with insufficient data as to the details. The injury may have resulted from improper dosage, too long an exposure, improper ventilation after fumigating, or the conditions for germination may have been so poor as to cause a distinct lowering of the percentage and this loss is then attributed to fumigation rather than to its true cause. A small number of experiments, no matter how accurate, can never be considered as giving a correct estimate of the work. Only by a large series of trials, if possible running up into the hundreds and, still better, thousands, can a correct average be obtained of the real effect on germination either from fumigating or sterilizing processes. In an effort to secure results of this type, a series of over fifty kinds of grains, legumes and nuts were treated under very severe conditions, either the dosage, time exposure or degree of heat being much greater than the maximum known to be effective. The seeds were then tested for germinating power and the nuts for impairment of flavor. The varieties tested included a number of common grains, beans and nuts so that it served the double purpose of being a varietal test and also one of sufficient numbers so as to give a fairly accurate average for the entire experiment. Each variety was subjected to exactly the same process, as samples of the entire series of grain, beans and nuts were in the oven or fumigatorium at the same time, while the entire bulk was not so large as to hinder a uniform distribution of either gas or heat. An average of about 75 seeds to the variety was used for each experiment. The varieties tested were as follows:

Wheat—Little Club, Baart, Australian White, Sonora.

Corn—Yellow Dent, Evergreen, Early Minnesota, White Dent, Honey Sorghum, Feterita, King Philip Flint.

Barley—Coast, Chevalier.

Oats—Black.

Rye—Unknown variety.

Rice (Paddy)—Sue Hiro, Wateribune.

Peanuts—Big Jumbo.

Alfalfa—Unknown variety.

Peas—Alaska Garden, Partridge.

Beans—Large Horse Bean, Small Horse Bean, Lady Washington, Bayo, White Tepary, Red Kidney, Red Mexican, Cranberry, Henderson Bush Lima, Garbanzo, Black Eyes, Pink.

Almonds—Ne plus ultra, Harriott, Texas, King, Reams, Klondyke, Drake, Big White Flat, Llewellyn, Nonpareil, California, Languedoc, IXL, Peerless.

All of these 58 varieties being subjected to eight different series, made a total of 464 experiments.

The effect on the germinating power of all the grains and vetches was very similar, so small in fact as to be almost negligible. No decided varietal difference was noted on any of the seeds tested or in the quality of the nuts. The almonds showed a slight impairment of flavor when exposed to high temperatures or for long periods to the action of either carbon disulphid or cyanide. A short exposure to either of these chemicals, even at a strong concentration or an eight hour exposure to a temperature of 125° F. all left them in apparently a normal condition.

The most striking variation was seen in beans, hence the report is shown in full for only this one group and for only seven of the eight series. The eighth series was at a similar temperature to number one, but for a shorter time, the results of the two being so alike as not to be worth repeating. This table then is a summary of seventy-seven experiments in which is seen a range in germination from 22 per cent to 100 per cent, and yet the average for the whole group is only 5 per cent less than that of the check, and small as was this loss in the beans, the variation for the grains was even less.

Beans are commonly reported to be especially liable to injury from fumigation, yet when the excessive dosages or temperatures that were used are considered it is seen that in most instances no injury whatever occurred and even these discrepancies may be and probably are, partly due to improper germinating conditions, for the greater variations come in temperature tests and are not in proportion to the degree of heat used. Every effort was made to have optimum germinating conditions, the work being done in a fairly constant temperature and all tests discarded that seemed to fail in any way.

Considering the table as a whole it would seem that beans are not so susceptible to this form of injury as is usually thought, providing the work has been carefully done and on cured stocks, these experiments being on dry beans. Isolated instances may be selected from the table which would give the impression that these treatments are dangerous. Just as occasionally we have reports of fumigation injury, but as a

whole it shows that fumigation and heat sterilization are safe practices both for grains and legumes at the dosages commonly used and with proper precautions as to the length of exposure and ventilation afterwards.

GERMINATION PERCENTAGE OF BEANS AFTER TREATMENT WITH EXCESSIVE DOSAGE

Variety	Heat	Heat	Heat	Cyanide	Cyanide	CS_2	CS_2	Aver.	Ck.
	Temp. 100–158° F.	Temp.[1] 124–154° F.	Temp. 125° F.	4 oz. to 100 cu. ft.	2 oz. to 100 cu. ft.	40 lbs. per 1,000 cu. ft.	30 lbs. per 1,000 cu. ft.		
	Time 5 hrs.	2 hrs.	8 hrs.	18 hrs.	5 hrs.	18 hrs.	42 hrs.		
	(1)	(2)	(3)	(4)	(5)	(6)	(7)		
Large Horse.....	97	94	88	100	98	96	73	91	100
Lady Washington	96	98	98	85	97	100	96	96	99
Bayo...........	96	100	96	95	100	96	100	97	100
White Tepary ...	100	39	98	97	88	95	98	88	89
Red Kidney.....	97	89	98	100	100	98	100	99	98
Red Mexican....	68	99	100	100	100	100	98	95	99
Cranberry.......	81	97	90	100	97	97	100	95	99
Henderson Bush Lima..........	22	96	96	87	100	93	80	79	94
Garbanzo........	96	65	76	75	100	72	100	83	94
Blackeye........	94	94	95	97	72	96	93	91	93
Pink............	100	96	99	90	100	100	100	98	99
Series averages...	86	88	94	93	96	95	95	92	97
Excess in time or strength used above........	10x at this Temp.	6x at this Temp.	1.6x at this Temp.	8x strength 18x time	4x strength 5x time	8x strength	6x strength 2x time		

[1] Temp. readings for series 2 are as follows: 10.45 a. m., 102° F., 1.30, 136° F., 3.45, 154° C.

ON THE ABSENCE OF INSECT PESTS IN CERTAIN LOCALITIES AND ON CERTAIN PLANTS[1]

By T. D. A. COCKERELL, *University of Colorado*

The reports of entomologists describe the ravages of insect pests where they occur, but are usually silent concerning the *absense* of infestation. In these days, when we are so greatly concerned to increase the available food-supply, it seems particularly important to ascertain where crops can be grown with the least danger from insect attack. My wife and I, having a "war-garden" in Boulder, Colorado, in 1918, gained some experience which may be worth relating. Our beans (*Phaseolus*) were completely overrun by *Epilachna corrupta*. It was thought that assiduous hand picking early in the season would abate the plague. It doubtless helped, and we got a good many beans; but the beetles came flying to the patch every

[1] This paper should have appeared with those read by title at the Baltimore meeting.—ED.

day, and eventually the plants were ruined. Experiments made at the Colorado Agricultural College not yet published, indicate that kerosene emulsion may be used with success against this insect, but it is impossible to get it applied uniformly over a town full of little bean-patches in back yards. It seems practically impossible to prevent numerous persons from raising enough bean-beetles to replenish the neighborhood. Now this *Epilachna*, for reasons not clearly understood, is of very restricted distribution. It abounds in the vicinity of the mountains, from northern Colorado to southern New Mexico. A short distance out on the plains it apparently ceases to be a serious pest. It eats only *Phaseolus*, so far as I can find; soy beans and other beans of different genera are untouched. It probably feeds on no wild plant in the vicinity of Boulder. By entirely omitting the cultivation of beans for a year or more, it could presumably be starved out, and subsequently beans could be grown with safety. In the immediate future, however, it is obviously indicated that beans should be grown in those localities where the *Epilachna* is absent or a very minor pest, and that in the *Epilachna* area the ground should be given to other crops.

Our experience with tomatoes has been very different. We got an early variety from Burbank, and the crop of the three varieties grown has been enormous. The season has been favorable, and up to the date of writing (October 11) the crop has been continuous, owing to the absence of frost. There have been no significant insect pests. Toward the end of summer, as we had observed for many years past, *Heliothis obsoleta* is very abundant in Boulder. I have observed it as early as July 27. I had thoughtlessly assumed that all these moths were of local origin, but it is now evident that they migrate from the south. Our tomatoes have been entirely free from the attacks of the larvæ, and our corn has been practically free, showing only light and negligible infestation toward the end of the season.

The tomato is not only edible as such, raw and cooked, but it may be made the basis of excellent jam. Mrs. Cockerell finds that it is possible to reduce the usual amount of sugar in the jam to a fourth, replacing the rest by commercial syrup. By increasing the acreage of tomatoes, in the region where these are not seriously injured by insects, it is possible to produce a great amount of food, much of which may be put up in the form of jam and preserves. It would, therefore, seem to be a very important function of the Entomologists to ascertain and designate the regions where tomatoes may thus be grown to the greatest advantage. It may mean the addition of hundreds of tons of food to our supplies in a single season. As with tomatoes, so with other crops. The everbearing strawberry has been a delightful sur-

prise to us in Boulder. As I write there stands before me a basket of strawberries, gathered today (October 11) by a neighbor. This plant, also, seems to have no important pests in this locality; or at any rate, it produces abundantly without any special treatment. We are probably in an optimum region for strawberries as well as tomatoes.

The girasole or Jerusalem artichoke (*Helianthus tuberosus*), of which we have a large experimental plot, is practically immune from insect or fungus attack, at least with us. Early in the season the young plants were attacked by cutworms, and it seemed that there would be some loss. But one shoot cut off, another came from a different "eye," and I believe that ultimately I did not lose a single plant.

Asparagus has been free from pests in our garden until recent years. The European asparagus beetle has now arrived and is very abundant. We have taken out most of the asparagus and replaced it by strawberries.

At this time of year it would be possible by sending out circular letters in sufficient numbers, to ascertain the optimum regions for different crops, taking into account insect and fungus attacks, soil and climate. Maps could be prepared showing these areas, with shading to indicate the minor variations. In this way, so far as one-season crops are concerned, it is possible that if the results were sufficiently widely advertised, a notable increase in production would result.

SOME RECENTLY RECORDED PARASITES OF THE ORIENTAL PEACH MOTH

By Louis A. Stearns, *Associate Entomologist, Virginia State Crop Pest Commission*

While making a preliminary canvass during the summer months of 1918, to determine the exact status of the Oriental Peach Moth (*Laspeyresia molesta* Busck) in Virginia, and to collect desirable data concerning the injury resulting from the feeding habits of this pest,[1] an accompanying study of its life history was carried on at the north Virginia field laboratory, Leesburg. Of more than six hundred larvæ collected from injured peach twigs and fruits in nearby infested orchards at different dates from mid-July until late September, and placed in vials for daily observations as to development, a large number were parasitized. During the latter part of this period, parasitism of larvæ and pupæ continued at an average of 35 per cent. Numbers

[1] "The Oriental Fruit Moth In Virginia"—Quarterly Bulletin, Va. State Crop Pest Commission, April, 1919.

of mature larvæ, which have ceased feeding in fruit, have been found to cocoon for hibernation as early as the 12th of September. The direct result of extensive parasitic attacks at this time of the year is, obviously, a material decrease in the size of the overwintering brood upon whose numbers the severity of spring twig infestation by this insect is indirectly dependent.

Eleven species of parasites were reared, seven of which have not been recorded previously as attacking the peach moth. A tachinid, *Euzenillia variabilis* Coquillett (det. C. T. Greene, U. S. Bureau of Entomology), the only dipterous parasite secured, had probably attacked the larva of its host prior to cocooning, and had then pupated within its partially constructed cocoon. During the latter part of the season, *Macrocentrus* sp. appeared in sufficient numbers to give it first rank in the records of hymenopterous parasites reared. According to Mr. R. A. Cushman, U. S. Bureau of Entomology, to whom the writer is indebted for determinations unless otherwise noted, this species, which parasitizes the codling moth (*C. pomonella*) as well, attacks the larva of the peach moth. While the larva feeds, the parasite develops, finally spinning its cocoon within that of its host. A number of specimens of *Dibrachys boucheanus* (Ratzeburg) (det. A. B. Gahan, U. S. Bureau of Entomology), the only secondary parasite reared, were taken from cocoons of *Macrocentrus* within which they had pupated. Of the remaining hymenopterous parasites, five—*Rhogas platypterigis* Ashm., *Habrobracon gelechiæ* Ashm., *Eubadizon gracilis* Prov., *Goniozus* sp. (det. S. A. Rohwer, U. S. Bureau of Entomology), and *Leucodesmia nigriventris* Girault (det. J. C. Crawford, U. S. Bureau of Entomology)—attack *L. molesta* in the larva stage; and three—*Itoplectis conquisitor* (Say), *Pimplidea æquallis* (Prov.), and *Phægenes* (*Centeterus*) sp. (det. A. B. Gahan, U. S. Bureau of Entomology)—attack *L. molesta* in the prepupa or pupa stages.

Experiments with various sprays, including those commonly recommended for the suppression of insect enemies of peach and the other deciduous fruits which this pest attacks, have been variable in their results—mostly unsatisfactory. The rôle played by these minute dipterous and hymenopterous forms in the control of this recently established insect cannot, therefore, be too highly valued at the present time.

THE STRENGTH OF NICOTINE SOLUTIONS

By V. I. Safro, *Louisville, Ky.*

The terms designating the strength of nicotine solutions are very often used quite loosely and in some cases erroneously. Too often, for instance, we see mentioned "40 per cent nicotine sulphate" when the intent is to specify "40 per cent nicotine *as* sulphate"—far from being an equivalent statement. It is highly desirable, then, that the factors that constitute the strength of nicotine solutions be well known and that certain old erroneous ideas be definitely disposed of. In order to bring this matter to the attention of entomologists, these nontechnical remarks are submitted.

When properly used as a spray, nicotine solutions are practically independent of sunlight, humidity, or any other atmospheric conditions for their effectiveness as contact insecticides, the problem in the field being concerned solely with wetting the insects thoroughly with a solution of the required nicotine strength. (The practice of using a greater nicotine strength is sometimes followed in order to make up for carelessness and lack of thoroughness on the part of the grower, or for the lack of spreading properties of the spray caused by using hard water without the addition of a sufficient softener and spreader.)

Odor No Indication of Comparative Strength.—Many growers make a practice of endeavoring to ascertain the comparative nicotine strength by the odor of the preparation. This has been a common practice among greenhouse men. As a matter of fact, the characteristic odor of tobacco is not due to nicotine. It is due to a great extent to the essential oils of the tobacco plant and to other extractive material with which we are at the present time not very well acquainted.

The writer has before him the following preparations:

100% Nicotine, 43% Nicotine, 3% Nicotine — Uncombined; *i. e.* "free"
40% Nicotine as sulphate
Tobacco oil (no nicotine)

An attempt to obtain the comparative nicotine value of these preparations by odor is impossible. The preparation that contains the strongest tobacco odor is the preparation of tobacco oil which contains no nicotine whatever. On the other hand, the preparation containing 100 per cent "free" nicotine possesses very little odor and that differing quite materially from the tobacco oil. In fact, the odor present in the sample of 100 per cent "free" nicotine has no similarity to the characteristic tobacco odor. The preparation containing 3 per cent

nicotine has a stronger odor than either the preparation containing the 43 per cent or the 100 per cent, the 43 per cent having very little odor indeed. The preparation of 40 per cent nicotine as sulphate has a stronger odor than the preparation of 100 per cent "free" nicotine and is again of a different character than the odor of any of the other nicotine preparations.

Color No Indication of Comparative Strength.—We have been accustomed to believing that the higher nicotine concentration, the darker the color. The coloring matter is almost entirely due to materials other than the nicotine extracted from the tobacco plant. The preparations mentioned above in demonstrating that odor has no relation to nicotine strength may also be used to show that color is no indication of comparative nicotine content. The preparations containing 43 per cent and 100 per cent nicotine are almost the same in color—a transparent red—and both are clearer and lighter in color than the 40 per cent nicotine as sulphate and the nicotine—free tobacco oil, both of which are dark brown in color, almost opaque, and heavier than the other preparations.

Per Cent Nicotine Content Alone Insufficient as Statement of Exact Strength.—Most of the commercial nicotine solutions on the market contain 40 per cent nicotine *by weight*. The nicotine may be in the form of "free" nicotine or in the form of nicotine sulphate, but the per cent refers to the amount of nicotine, by weight, because it is the only method of knowing definitely how much actual nicotine is contained in the solution and such designation is required by the Federal Insecticide Board. It is necessary, then, to know the specific gravity of the preparation in order to know the actual nicotine content.

Below is a list of three commercial preparations, each containing 40 per cent nicotine by weight, showing the variations that exist in several preparations.

Preparation	Sp. Gr.	Approx. Weight Per Gal.	Pounds Nicotine Per Gal.
A	1.20	10 lbs.	4 lbs.
B	1.0	8 "	3.2 "
C	.927	7.4 "	2.97 "

Dilutions, being by volume, would in the case of each of the above 40 per cent preparations give solutions of widely different nicotine content, granting that the same dilution is used with each preparation.

Per Cent Nicotine Content together with Specific Gravity Constitutes Statement of Exact Strength and Comparative Value.—In order to know the definite value of a nicotine solution,

the total *weight* of nicotine in the solution should be known. In the three commercial preparations mentioned above, each preparation is labelled 40 per cent nicotine and yet in one case four pounds of nicotine and in another only 2.97 pounds of nicotine are contained in the same volume of solution.

Scientific Notes

European Elm Scale. On May 27th, the writer found an American elm on the college grounds infested with European elm scale (*Gossyparia spuria*). This, apparently, is the first time the insect has made its appearance at Ames. The college collection has a specimen from Des Moines, but we have been unable to find a published record for this state. ALBERT HARTZELL, *Ames, Iowa.*

European Corn Borer (Pyrausta nubilalis Hubn.) in New York. A recent determination by Messrs. Heinrich and Schaus, through the courtesy of Doctor L. O. Howard, of moths reared from corn stalks collected near Schenectady has positively established the occurrence of this serious pest in New York State. A subsequent identification by Mr. Heinrich of moths reared from corn boring larvæ suspected of being *Pyrausta nubilalis* has shown the Dutchess County insect to be *Pyrausta penitalis* Grote. This is welcome news and unless upset by subsequent discoveries, means that European corn borers occur in but one area in New York State and probably in but two in the United States. E. P. FELT.

Corn Borer in Connecticut not the European Species. In this JOURNAL for April, page 218, is a note to the effect that "what appears to be a small infestation of the European corn borer was found in Milford, Conn., March 12." Adults have now been reared from this material and we are pleased to announce that they have been identified by specialists at Washington as *Pyrausta penitalis* Grote, and not the European corn borer, *Pyrausta nubilalis* Hubner. W. E. BRITTON.

Swarms of Aphids. On June 23 and 24 vehicles and pedestrians passing through Chapel Street, and some other nearby thoroughfares in New Haven, Conn., were literally covered with small green insects which were flying in the air and were caught on the clothes, and tops of automobiles. One of the seed stores telephoned to my office inquiring what they were; some of their customers took them to be the arrival of the much heralded "seventeen year locust." On investigating the matter they were found to be aphids, afterwards identified by Dr. Edith M. Patch as *Calaphis betulæcolens* Fitch, a species infesting birch and supposed to remain upon that host throughout the season. Just why they migrated is a conundrum, unless because they became so abundant that they were forced to leave in search of food. Though there are a few birches in the city, there are doubtless many acres on the Orange hills, two or three miles to the southwest, from whence they came. Several observers noticed the swarms of aphids in New Haven and Hamden at this time and also the preceding week. W. E. BRITTON.

Army Entomological Laboratory. Malcolm E. MacGregor, a Carnegie student who studied in this country several years ago, informed Dr. Howard in a recent letter that he is in charge of the War Office Entomological Laboratory, Kitchener Camp, Sandwich, Kent, adding that the tropical campaigns have made the English tumble on many facts which they could not see before. The laboratory exemplifies the last word in modernity, all the apparatus being run by electricity and the equipment being beautiful in every way. Mr. MacGregor extends a most hearty welcome to any American entomologist who may be visiting in England. E. P. F.

JOURNAL OF ECONOMIC ENTOMOLOGY

OFFICIAL ORGAN AMERICAN ASSOCIATION OF ECONOMIC ENTOMOLOGISTS

AUGUST, 1919

The editors will thankfully receive news items and other matter likely to be of interest to subscribers. Papers will be published, so far as possible, in the order of reception. All extended contributions, at least, should be in the hands of the editor the first of the month preceding publication. Contributors are requested to supply electrotypes for the larger illustrations so far as possible. Photoengravings may be obtained by authors at cost. The receipt of all papers will be acknowledged —Eds.

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The Albany Conference on the European Corn Borer situation should accomplish two things. It should first of all aim to give all those attending the fullest possible information respecting the insect and the condition of the infested territory. Much of the former is familiar to entomologists though there have been a number of new developments during the summer. The more salient facts concerning the status of the borer as a pest and the possibility of exterminating it should receive special consideration at the hands of all present. There will be an opportunity of examining the infested territory in both New York and Massachusetts at a time when the work may be expected to show to best advantage and this should not be neglected by any having more or less responsibility for the control of injurious insects in the corn growing sections of the United States.

The main object of the conference is to agree upon a policy which will be acceptable alike to scientists and administrators, and one that can be carried to a successful conclusion. The possible as well as the practical should receive due attention and most important of all, an effort should be made to depict clearly the ultimate results of the various policies, if there be different ones advocated. The American people are coming to rely more and more on the decisions of experts. The apparently impossible is becoming commonplace in these stirring days. This conference may mean the beginning of startling developments in insect control. It is for the entomologists of this country to anticipate the future so far as practicable and present a feasable program and then stand as a unit for its execution.

Current Notes

Conducted by the Associate Editor

Dr. A. D. Hopkins of the Bureau of Entomology visited the Ohio Station, March 30.

The University of California has conferred the doctorate of laws upon Prof. Vernon L. Kellogg of Stanford University.

Prof. H. A. Gossard of the Ohio Agricultural Experiment Station, addressed the Paper Shell Pecan Grower's Association at Chicago, March 8.

Mr. R. W. Wells of the Bureau of Entomology has been detailed to conduct work on biting flies of cattle in coöperation with the Nevada Station.

Mr. H. E. Hodgkiss, formerly of the Agricultural Experiment Station, Geneva, N. Y., is now professor of entomology extension, State College, Pa.

Mr. Quincy S. Lowry is spending the summer on corn borer work for the Massachusetts State Board of Agriculture, and at present is located in Lexington, Mass.

Mr. J. R. Stear, formerly assistant in entomology at the Ohio Agricultural Experiment Station, has accepted a position with the Pennsylvania State Department of Agriculture.

Dr. W. C. Woods is spending the summer at the Agricultural Experiment Station, Orono, Maine, studying the Chrysomelidæ. He will return to Wesleyan University, Middletown, Conn., in the fall.

According to *Science*, the honorary professional degree of master of horticulture has been conferred upon Edmund H. Gibson of the U. S. Bureau of Entomology, by the Michigan Agricultural College.

According to *Science*, two new laboratory buildings are planned for the College of Agriculture at Los Banos, Philippine Islands, one of them to house the department of entomology and plant pathology.

Dr. M. W. Blackman, Department of Forest Entomology, New York State College of Forestry, Syracuse University, is at the Agricultural Experiment Station, Orono, Maine, for the summer working upon forest insects.

Mr. Lloyd R. Watson, extension worker in apiculture in Connecticut for the past year, has been permanently transferred to the apicultural laboratory of the Bureau of Entomology at Washington, D. C., as special field agent.

According to *Science* the title of Commander of the Order of the Crown of Belgium has been conferred on Dr. W. J. Holland, director of Carnegie Institute, Pittsburgh, Pa., in recognition of the "devotion shown by him to the cause of Belgium."

According to *Science*, Lieut. Asa C. Chandler, Sanitary Corps, formerly assistant professor of zoölogy at Oregon Agricultural College, has undertaken parasitological work at the Central Medical Department Laboratory of the A. E. F. at Dijon, France.

Dr. H. H. Knight, formerly of Cornell University, was discharged from the Army in April, and has since accepted an assistant professorship in entomology at the University of Minnesota. His work will be almost wholly systematic in character.

Mr. Don C. Mote, formerly Economic Zoölogist, Ohio Agricultural Experiment Station, was appointed State Entomologist of Arizona by the Arizona Commission of Agriculture and Horticulture. He assumed the duties of the new office July 1, 1919.

A school and conference for beekeepers will be held at the University of Wisconsin College of Agriculture, Madison, Wis., August 18–23. In addition to local instructors, Dr. E. F. Phillips and Mr. G. S. Demuth of the Bureau of Entomology are on the program.

Prof. W. C. O'Kane of the New Hampshire College and Experiment Station and president of this Association is ill and has been ordered by his physician to take a complete rest. He has been obliged to drop his work probably for the remainder of the summer.

According to Entomological News, deaths of European entomologists are announced as follows: W. F. de Vismes Kane, Ireland; Sydney Webb, England; Dr. Raphael Blanchard, J. K. D'Herculais, France; Grand Duke Nicholas Michailovitch, K. Robert, Russia.

By recent act of the legislature of Pennsylvania, the Bureau of Economic Zoölogy has been eliminated, and a Bureau of Plant Industry created embracing all the duties of the old Bureau with additional ones. J. G. Sanders is Director and W. A. McCubbin Deputy Director of the new Bureau of Plant Industry.

C. L. Metcalf of Ohio State University is teaching biology in the summer session of the New York State College of Agriculture. Professor Metcalf received the degree of Doctor of Science from Harvard University in June. He will return to the Department of Zoölogy and Entomology in Ohio State University in August.

Mr. Roger C. Smith has been awarded the one-hundred dollar Walker Prize in Natural History given by the Boston Society. He submitted a paper on "The Biology of the Chrysopidæ," his doctor's thesis, which will very likely be published as a memoir of the Cornell University Agricultural Experiment Station.

Professor Herbert Osborn is spending a few weeks at the North Carolina Agricultural Experiment Station, working on Homoptera with Z. P. Metcalf. He was injured in an automobile accident, had a narrow escape, and was laid up for a month with bruises and strains, but is now able to do laboratory work and some field collecting.

According to *Science*, Dr. Frank E. Blaisdell, Sr., of Stanford University, and Mr. E. P. Van Duzee, curator of the entomological department of the California Academy of Sciences, will spend their summer vacation studying the entomological fauna of the Lake Huntington region, Fresno county, California, at an elevation of 7,000 feet.

Among the papers read before the thirty-ninth annual meeting of the Society for the Promotion of Agricultural Science at Baltimore, January 6 and 7, was the presidential address, "The Problem of the Permanent Pasture with Special Reference to Its Biological Factors," by Professor Herbert Osborn, and "Some Codling Moth Life History Studies," by C. P. Gillette and G. M. List.

Mr. George M. Codding, who for fifteen months was employed as extension entomologist in Connecticut by the Bureau of Entomology, has accepted a position with the F. A. Bartlett Co., Stamford, Conn., Tree Surgeons, Entomologists and Foresters. Mr. Codding was employed under the act to stimulate agriculture during the war and his position terminated June 30, by limitation, as the appropriation was not renewed.

Dr. Arthur H. McCray, State Bacteriologist of Montana and formerly of the Bureau of Entomology, died of spotted fever June 14, 1919. Dr. McCray was born November 14, 1880, and graduated from the Ohio State University in 1908. While

serving with the Bureau of Entomology his work was connected with bee diseases, on which several papers were published. He was graduated from the Medical department of George Washington University in 1915. He was ill eleven days before his death.

The following resignations from the Bureau of Entomology are announced: H. W. Lee, to enter business; H. H. Nininger, to become special extension entomologist for Kansas; F. H. Gates, to enter commercial work at Phoenix, Ariz.; A. P. Swallow, to become extension entomologist in truck crop insects at the Texas Agricultural College; Stewart Lockwood to enter State work, North Dakota; C. W. Creel to become State extension entomologist, Nevada; W. E. Dove; Dr. W. Dwight Pierce to enter private business.

Dr. C. L. Marlatt, assistant chief of the Federal Bureau of Entomology, and chairman of the Federal Horticultural Board, visited the Kansas State Agricultural College May 19. He gave a very instructive address to the Entomological and Zoölogical Seminary on some work of the Federal Horticultural Board. Dr. Marlatt, who is an alumnus of the Kansas State Agricultural College, was a member of the entomological staff in that institution from 1884 to 1888, at which time he resigned to enter the service of the Federal Bureau of Entomology.

According to *Science*, Mr. Charles W. Leng, secretary of the New York Entomological Society and research associate in the American Museum of Natural History, has been appointed director of the museum of the Staten Island Institute of Arts and Sciences, and began his duties June 1st. Mr. Leng has been interested in the natural history of Staten Island, where he was born and lives, since boyhood. Entomologists and other naturalists, visiting New York City, can reach the museum of the institute by a pleasant half hour's sail across the bay on the Staten Island ferry.

At a meeting of the Board of Regents of the University of Nebraska during the latter part of May, Professor Lawrence Bruner, who has been in charge of the entomological activities in Nebraska for the past thirty years, was retired from active service on part salary, owing to his continued ill health. Prof. Myron H. Swenk, who has been in active charge of the entomological work of the state for several years past, was made chairman of the Department of Entomology in the University, state entomologist of Nebraska and entomologist in the Experiment Station.

According to *Science*, Mr. J. G. Sanders, director of the Bureau of Plant Industry of the Pennsylvania Department of Agriculture, at Harrisburg, Pa., has been commissioned by the Federal Horticultural Board at Washington to study the potato wart disease in the British Isles, and to note the methods adopted for controlling the spread of this most dangerous potato diease. The potato wart disease was first determined by him to occur in the United States in a district comprising four counties in the vicinity of Hazleton, Pa., in September, 1918. These four counties, with three outlying points, are now under strict quarantine.

According to *Science*, an entomological expedition to South America is planned by Prof. J. Chester Bradley, '06, of the College of Agriculture of Cornell University. Leaving Ithaca next September, Professor Bradley will visit Brazil, Argentina, and Chile; in the following spring he will be joined in Peru by Professors Cyrus R. Crosby and Dr. W. T. M. Forbes, of the Agricultural College, and the party will work on the Amazon River as far as Peral near the headwaters. The expedition is conducted under the auspices of the university for the two-fold purpose of securing entomological specimens and of forming closer relations with South American institutions of learning.

The following transfers are announced in the Bureau of Entomology: Geo. W. Barber to corn borer work, Arlington, Mass.; L. G. Gentner from extension to investi-

gational work on truck crop insects in Wisconsin; O. D. Deputy to have charge of all border fumigation work, Texas; L. P. Rockwood in charge of field laboratory at Forest Grove, Ore., made vacant by the resignation of C. W. Creel; Mortimer W. Leonard, extension entomologist in New York state to truck crop insects and to estabish a field station on Long Island for the study of potato insects; W. A. Thomas extension entomologists in North Carolina, to truck crop insects to establish a field station in that state.

The following appointments have been made recently in the Bureau of Entomology: Harry Sargent, port inspection work, Seattle, Wash.; C. A. Bennett, entomological inspector, Washington, D. C.; Joe Milam, J. D. Smith, J. W. Hill, Clarksville, Tenn.; L. Z. Naylor, boll weevil laboratory; H. Y. Gouldman, plant quarantine inspector, Washington, D. C.; W. H. Goodwin, C. H. Hadley, plant quarantine inspectors, Riverton, N. J.; Robert Fouts, specialist in hymenoptera, U. S. National Museum, Washington, D. C.; William R. Irving, bean weevil investigations, Alhambra, Cal.; J. W. Sauer, sweet potato weevil investigations, Kingsville, Tex.; D. Arthur Perry and K. W. Babcock, temporary field assistants corn borer work; Miss Harriet L. Arnold, Tempo, Ariz; M. L. MacQueen, L. N. Judah, Scott C. Lyon, T. P. Weakley and James T. Lewis temporarily, tobacco insect investigations; W. E. Haley, temporarily, Sugar Cane Insect Laboratory, New Orleans, La.

According to *Science*, mosquitoes representative of all species occurring at camps or posts where troops of the United States are stationed are to be collected for the Army Medical Museum in Washington. At present the collection is incomplete and medical officers have been directed to see that collections of these insects are made at the times and in the manner described in circular instructions being published. Collections of mosquitoes are to be made at each station at least biweekly, at three periods during the twenty-four hours, early morning from 5 to 6 a. m., midday, and after 7 p. m. The times of collection will vary in different latitudes, but observation will determine the time when the insects are most prevalent at each locality. They are to be collected by means of a suitable killer or by mosquito traps. The "chloroform tube" is the best and most easily obtained killer, and mosquito traps are also useful. Shipments of the mosquitoes in lots of 25 each in specially prepared boxes are to be mailed by medical officers at camps to the curator, Army Medical Museum, Washington, D. C.

The Arizona State Legislature at its recent session appropriated $65,350 for the work of the state entomologist during the ensuing biennium, also $2,775 for the present fiscal year to meet a prospective deficiency arising from increased costs of operation. The new appropriation includes an increase of $21,000 over the last biennial appropriation. This increase is due in part to the increased costs and in part to the extension of the Egyptian cotton growing industry in the state, the cotton crop ranking ahead of all other crops in valuation in 1918. In addition to the appropriation bills one other bill was enacted which is of much importance to the work of the state entomologist. This amends the law creating the Arizona Commission of Agriculture and Horticulture in important particulars with reference to qualifications for membership on the commission. After June 15, 1919, each of the three members, in addition to being the owner of improved agricultural land within the state, must be engaged in fruit growing or some branch of farming as his "principal occupation and business" and he must file a sworn statement that he is fully qualified as specified by the law. The director of the Experiment Station will not be an ex-officio member of the new commission as in the past. Definite terms of office are provided with one vacancy every two years. In the event any member during his term ceases to possess any of the specified qualifications his membership automatically ends.

Mailed August 18, 1919.

EXCHANGES.

Exchanges or Wants of not over three lines will be inserted for 25 cents each to run as long as the space of this page will permit; the newer ones being added and the oldest dropped as necessary. Send all notices and cash to A. F. Burgess, Melrose Highlands, Mass., by the 15th of the month preceding publication.

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HUGH GLASGOW, Agricultural Experiment Station, Geneva, New York.

WANTED—Systematic and economic papers on the families *Bombyliidae* and *Asilidae*. Mail descriptive list of titles and prices desired. H. R. HAGAN, Utah Experiment Station, Logan, Utah.

WANTED—SYRPHIDAE—from all parts of the world. Will determine on the usual conditions. Address until June 15, Prof. C. L. METCALF, Bussey Institution, Forest Hills, Boston, Mass. Afterward Ohio State University, Dept. Entomology, Columbus, Ohio.

WANTED—Trans. Am. Entomological Society, Vol. 3; Lintners 3rd Report (1886); Entomological News, Vol. 2, No. 10 (Dec. 1891); Farmers' Bulletins 7, 8, 10, 12, 89, 117, 214, 268, 356, 556, 558, 839, 878, 905, 911.

P. T. BARNES, Department of Agriculture, Harrisburg, Pa.

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A DOSAGE SCHEDULE FOR CITRUS FUMIGATION WITH LIQUID HYDROCYANIC ACID[1]

By R. S. Woglum, *Bureau of Entomology, United States Department of Agriculture, Alhambra, Cal.*

The advent of liquid hydrocyanic acid into the field of fumigation has brought about radical changes in application and presented problems whose solutions appear necessary before the use of this recently introduced material is placed on the stable basis required for effective orchard treatment. In an effort to develop further information on this subject the writer carried on, throughout the fumigation season of 1918, extensive experiments, which included operations covering several hundred acres of orange and lemon trees, both large and small, infested with the black, purple or red scales. In this work liquid hydrocyanic acid, 95 to 98 per cent pure, was used, the application being made in the form of a spray by special machines designed for this purpose. Many parallel experiments with pot- and machine-generated gas were performed. One outcome of this study has been the accumulation of data showing that the dosage schedule originally prepared for pot-generation of gas is not fully satisfactory in its present form for use with liquid hydrocyanic acid. This paper attempts to show the comparative efficacy of liquid hydrocyanic acid and pot-generated gas, and presents a new dosage schedule adapted to citrus fumigation with liquid hydrocyanic acid, 95 to 98 per cent pure.

[1]The writer wishes to acknowledge the assistance given by Mr. M. B. Rounds who performed an active part in much of the experimental work on which this paper is based.

This paper was not received in time for inclusion in the Proceedings of the Pacific Slope Meeting, published in the October issue. [Ed.]

Comparative Effectiveness of Pot-generated Gas and Liquid Hydrocyanic Acid

The purity of sodium cyanide used in California since its introduction for fumigation by the writer in 1909 has averaged about 97 per cent, according to analyses made of representative samples from time to time. In pot-generation not all of the cyanogen is given off as gas but many analyses made by the Bureau of Chemistry of the United States Department of Agriculture have shown that 90 to 95 per cent (average 93 per cent) of the total available hydrocyanic acid is evolved. A 93 per cent gas evolution from a 97 per cent sodium cyanid is equivalent to 20.2 cubic centimeters of 100 per cent liquid hydrocyanic acid (60° F., specific gravity .6969), or 20.9 cubic centimeters of 96 per cent hydrocyanic acid this last purity being considered a standard for field use. The schedules in common use for fumigation in California are based on the gas delivery from sodium cyanid generated in pots; therefore, to deliver a gas equal in amount would require approximately 20.9 cubic centimeters of 96 per cent liquid hydrocyanic acid for each ounce of solid sodium cyanid in any given dosage. It happens that the machine commonly used this past season for applying liquid hydrocyanic acid in field fumigation was graduated to deliver 16.56 cubic centimeters as equivalent to each ounce of solid sodium cyanid, which is approximately 21 per cent below requirements as based on gas delivery in pot-generation. In short, where commercial fumigation in California during the past season was based on the same dosage schedule in liquid as in pot- and machine-generation there was applied approximately 21 per cent less gas to the trees under the former method than the latter.

It was shown by the writer in a paper presented at the thirty-first annual meeting of this Association that the gas distribution is essentially different in pot- or machine-generation from that obtained with liquid hydrocyanic acid under the present method of application. It is a matter of common knowledge that the best scale-kill on trees treated with pot- or machine-generated gas is toward the top of the tent, whereas in the case of trees treated with liquid hydrocyanic acid at the warmer temperatures of fumigation it was demonstrated that the killing is the best toward the bottom of the tree. Since very much the larger proportion of insects, especially the black and purple scales, is toward the bottom of the tree, the very desirable condition exists of the heaviest infestation of insects and the greatest concentration of gas being distributed at the same place. This is the ideal for effective fumigation, and is, very probably, the principle reason for the increased efficiency of liquid hydrocyanic acid over pot-generated gas.

The following experiment, which presents results typical of field experience with medium sized trees badly infested with purple scale, shows the comparative effectiveness of 98 per cent liquid hydrocyanic acid and pot-generated gas against this insect at temperatures between 65° and 70° degrees F., when the pump delivered 16.56 cubic centimeters of liquid hydrocyanic acid as corresponding to each ounce of cyanid and consequently delivered an amount of gas approximately 21 per cent less than that evolved from the pots, as previously explained.

Table I. Comparative Scale-Kill at Temperatures 65° to 70° F. Between 98 Per Cent Liquid Hydrocyanic Acid and Pot-Generated Gas. The Liquid Hydrocyanic Acid was Used at the Rate of 16.56 Cubic Centimeters as Equivalent to 1 Ounce Sodium Cyanid and on this Basis the Same Dosage Schedule was Followed.

Method of Treatment	Dosage Unit		Bottom of Trees	Top of Trees	Total for Trees
Pot System	Ozs. 97% Sodium Cyanid	Scale Examined	2168	664	2832
		Per cent Living	4.3	3.3	4.0
Liquid HCN	16.56 cc. 98% Liquid HCN as Equivalent to 1 oz. NaCN	Per Cent Living	2.7	8.4	5.4
		Scale Examined	1494	1338	2832

An examination of this table shows the results with liquid hydrocyanic acid at this strength to be better at the bottom of the trees than for the pot-generated gas, although toward the top of the trees the reverse is true, a decidedly greater percentage of scale being killed at this latter part in the case of the pot-fumigated trees. The total result for the whole tree is slightly favorable to the pot treatment and shows that, under the stated conditions, 16.56 cubic centimeters of liquid hydrocyanic acid is insufficient to produce results equivalent to 1 ounce of sodium cyanid in pot-generation.

Other experiments with medium-sized to large trees were performed against the purple scale at the higher temperatures of fumigation, using in some cases 21 to 22 cubic centimeters of liquid hydrocyanic acid as equivalent to the ounce of sodium cyanid, and where this dosage rate was applied in connection with the same schedule followed in securing the results presented in Table I the mortality average above 99 per cent. Since the average mortality of purple scale under certain conditions was shown to be 94.6 per cent with 16.56 cubic centimeters of high purity liquid hydrocyanic acid as equivalent to the ounce of sodium cyanid, and other experiments against this insect conducted under practically identical conditions with 21 to 22 cubic

centimeters of liquid hydrocyanic acid as the ounce equivalent gave a mortality above 99 per cent, it is apparent that the amount of this liquid required to produce results comparable to the 96 per cent mortality secured with pot-generation comes within the limits of 16.56 and 21 cubic centimeters and approaches the lower figure more closely than the larger. Study of our complete data on purple scale fumigation, supplemented by that on black and red scales, led to the conclusion that 18 cubic centimeters of high purity liquid hydrocyanic acid approximates the equivalent of one ounce of sodium cyanid on average sized trees fumigated at the ordinary temperatures of treatment as closely as any fixed quantity can for orchard work. These results indicate a decided economy of material over the requirements of pot-fumigated trees.

In the case of red scale on small trees the comparison is not quite as favorable toward liquid hydrocyanic acid as shown by the following experiments which are typical of many performed against this scale:

Table II. Comparative Scale-Kill on Young Trees Between Pot-Generated Gas and 97 Per Cent Liquid Hydrocyanic Acid, the Latter Used at the Rate of 16.56 Cubic Centimeters and 19.2 Cubic Centimeters to the Ounce of Solid Sodium Cyanid. The Same Dosage Schedule was Followed for All Trees.

Method of Treatment	Dosage Unit		Bottom of Tree (1 to 3 ft.)	Top of Tree (4 to 7 ft.)	Total for Tree
Pot System	Ozs. 97% Sodium Cyanid	Scale Examined	20884	28924	49808
		Per Cent Living	2.1	1.0	1.5
Liquid HCN	16.56 c.c. 97% Liquid HCN as Equivalent to 1 oz. NaCN	Scale Examined	12823	8619	21442
		Per Cent Living	2.4	5.4	3.6
Liquid HCN	19.2 c.c. 97% Liquid HCN as Equivalent to 1 oz. NaCN	Scale Examined	5597	6400	11997
		Per Cent Living	0.8	1.55	1.2

An examination of the above table shows that the results with liquid hydrocyanic acid at the rate of 16.56 cubic centimeters as equivalent to 1 ounce of solid sodium cyanid were much poorer than for the pot-treated trees. However, where 19.2 cubic centimeters of liquid hydrocyanic acid for each ounce of cyanid were used the results are about equal to pot-generated gas as taken for the whole tree. These experiments show that a slightly less amount of liquid hydrocyanic acid than pot-generated gas is required for small trees. The economy is less than for medium to large sized trees.

A New Dosage Schedule

The necessity of a special schedule for use with liquid hydrocyanic acid is at once apparent by an examination of the complete results in Tables I and II, which compare liquid hydrocyanic acid and pot-generated gas. Such a schedule has been prepared and is herewith presented. It is the product of nine months continuous field experiment and observation during which records were kept on several hundred acres of fumigated trees for the black, purple and red scales.

Dosage Schedule for Citrus-Tree Fumigation with Liquid Hydrocyanic Acid 95-98 Per Cent
Distance around in feet

	12	14	16	18	20	22	24	26	28	30	32	34	36	38	40	42	44	46	48	50	52	54	56	58	60	62	64	66	68	70	72	74	76	78	
10	2	2	3	3	3																														10
12	3	3	3	4	4	4	4																												12
14	3	3	4	4	4	4	5	5																											14
16	4	4	4	4	5	5	5	5	5	5	5	6																							16
18	4	4	4	5	5	5	5	5	6	6	6	6	6																						18
20			4	5	5	5	6	6	6	6	7	7	7	7	7	7	7																		20
22					5	6	6	6	7	7	7	7	7	8	8	8	8	8																	22
24					6	6	6	7	7	7	7	8	8	8	8	8	9	9	9																24
26								7	7	8	8	8	8	9	9	9	9	9	10	10															26
28									8	8	8	9	9	9	9	10	10	10	10	11	11	11													28
	12	14	16	18	20	22	24	26	28	30	32	34	36	38	40	42	44	46	48	50	52	54	56	58	60	62	64	66	68	70	72	74	76	78	
30										8	9	9	9	10	10	10	11	11	11	12	12	12	12	13	13										30
32											9	9	10	10	11	11	12	12	12	13	13	13	14	14	14	15									32
34												10	10	11	12	12	13	13	13	14	14	14	15	15	15	16	16								34
36												10	11	12	12	13	13	14	14	15	15	16	16	16	16	17	17								36
38													12	12	13	14	14	15	15	16	16	17	17	17	18	18	18	19							38
40																14	15	16	16	17	17	18	18	18	19	19	19	20	20	21					40
42																	16	17	17	18	18	19	19	20	20	20	21	21	22	22	22				42
44																		17	18	19	19	20	20	21	21	21	22	22	22	23	23	24			44
46																				20	20	21	21	22	22	23	23	23	24	24	24	25	25	26	46
48																				20	21	22	22	23	23	24	24	25	25	25	26	26	27	27	48
	12	14	16	18	20	22	24	26	28	30	32	34	36	38	40	42	44	46	48	50	52	54	56	58	60	62	64	66	68	70	72	74	76	78	
50																				21	22	23	23	24	24	25	25	26	26	27	27	28	28	29	50
52																							24	25	25	26	26	27	27	28	28	29	30	30	52
54																								25	26	27	28	28	29	29	30	31	31	32	54
56																									27	28	28	29	30	31	31	32	33	33	56
58																									28	28	29	30	31	32	33	33	34	34	58

Unit charge=18 cubic centimeters

In being based on the results of field practice rather than being a laboratory calculated schedule prepared in accordance with theories of leakage, size, shape, etc., it is to be expected that the dosage will not in every case be found to conform perfectly with mathematical calculations as based on such theories. However, it is believed that in its present form this schedule has been so carefully prepared that it will approximate uniform results in orchard treatment regardless of the size of the tree and prove fully as satisfactory as the original schedule prepared for pot-fumigation.

A critical examination of the schedule shows certain outstanding features. Small trees are dosed almost in proportion to cubical contents, larger sized trees approximate the ratio of surface area of a domed-shaped figure to its cubical contents. The tendency is for tall trees to receive a heavier dosage than low trees having the same cubical contents.

Each unit of dosage in this schedule is based on a delivery of 18 cubic centimeters of liquid hydrocyanic acid, 95 to 98 per cent pure, in the form of a very fine spray beneath the tented tree. Thus a tree 30 feet over by 40 feet around calls for 10 charges of 18 cubic centimeters (180 cubic centimeters). By graduating the machines used in generating the gas in numbers corresponding to those on the schedule and providing that each graduation delivers a charge equal to the number of cubic centimeters of which itself and 18 are the product, this schedule is made equally practical to former schedules.

This dosage schedule is based on the same dimensions of tented trees as was the original Schedule I for pot-fumigation, *i. e.*, the distance around the tented tree and the distance over the middle from ground to ground. The correct dosage for any tree is found in the square formed by the intersection of the lines running from the two numbers representing these measurements. It is expected to give results equivalent to Schedule I for potassium or Schedule I for sodium cyanid and should be substituted for these schedules wherever formerly employed in pot- or machine-generation.

At a temperature of 40° F., the superiority of liquid hydrocyanic acid to pot-generated gas is not so marked as at higher temperatures of fumigation. Therefore, it will be necessary in fumigation at such low temperatures to increase the dosage over that used during warm weather.

A three-quarter or 75 per cent schedule was originally prepared by the writer for pot work and many others, such as 65, 85, 110, 120 and 125 per cent schedules have been calculated by others. The necessity of such a large number of schedules is questionable. Furthermore, the original identity of these schedules is frequently lost by field use and thereby sometimes becomes a source of confusion to the fumigator. The preferable method, and the one advocated at this time by the writer, is to have differently graduated attachments which are easily and quickly adjustable to liquid "gas" machines when different schedules are required. These will insure uniformity for all dosages and require only one dosage chart for all fumigation. Such attachments graduated on the unit delivery basis of 14 cubic centimeters, 16 cubic centimeters and 20 cubic centimeters, when used with the new dosage chart, will produce the equivalent of 78, 89 and 111 per cent schedules,

and meet the major demands in orchard fumigation. A limited stock of 22 cubic centimeter graduated attachments would assure a correct delivery to those few fumigators who occasionally use 120 to 125 per cent schedules.

The purchase of liquid hydrocyanic acid should be by the pound. One pound of 96 per cent liquid hydrocyanic acid (60° F., specific gravity .702) measures 647 cubic centimeters and contains 36 charges of 18 cubic centimeters.

RESPONSE OF THE EGGS OF APHIS AVENÆ FAB. AND APHIS POMI DEG. TO VARIOUS SPRAYS, PARTICULARLY CONCENTRATED LIME-SULFUR AND SUBSTITUTES, SEASON OF 1918–1919

By Alvah Peterson, *Assistant Entomologist, New Jersey Agricultural Experiment Station*

For three seasons, 1916–1919, careful observations have been made on the behavior of three important species of plant lice occurring on apple trees: *A. avenæ** Fab., *A. pomi* DeG., and *A. sorbi* Kalt. In this paper particular attention is given to the behavior of the egg stage of two species and their response to various chemicals and common contact sprays. Additional observations have been made on the influence of environmental factors, particularly evaporating factors, on the eggs during the entire dormant season and also a distinct relationship has been found to exist between the killing efficiency of the spray material and its spreading quality, but space will not permit a report on these points at this time. The author's observations for 1916–1918, and also important observations made by Dr. T. J. Headlee, may be found in the papers cited below.[1]

During the past season, 1918–1919, many of the observations and experiments, particularly spraying experiments conducted the pre-

**Aphis avenæ* Fab. referred to is apparently *Aphis prunifoliæ* Fitch and *Aphis sorbi* Kalt. is *Aphis malifoliæ* Fitch.

[1] Headlee, T. J., 1916. Apple Plant Lice. In N. J. Agr. Expt. Sta. 38th Ann. Rept., pp. 494–501.

Headlee, T. J., 1918. Some Important Orchard Plant Lice. In N. J. Agr. Expt. Sta. Bull. 328.

Peterson, Alvah, 1917. Studies on the Morphology and Susceptibility of the Eggs of *Aphis avenæ* Feb., *Aphis pomi* DeGeer, and *Aphis sorbi* Kalt. In Jour. Econ. Ent., Vol. 10, pp. 556–560.

Peterson, Alvah, 1919. Some studies on the Eggs of Important Apple Plant Lice. In N. J. Agr. Expt. Sta. Bull. 332.

vious years, were repeated and the results obtained were almost identical with those of former years.

Observations

The eggs of *A. avenæ* were exceedingly abundant in many orchards throughout New Jersey during 1918–1919, particularly in the central and southern parts. This species was the only one present in John Barclay's orchard near Cranbury, N. J. Consequently all of the 75,000 eggs of *A. avenæ* used in the various spraying experiments were obtained from this orchard. No other species was seen from October 10 to December 10, 1918, when the females were depositing their eggs and also the nymphs observed after March 21, 1919, were *A. avenæ.* The eggs were present in such large numbers that they could be found on the smaller branches of all the trees and in many cases on the large branches. Some of the trees (ten years old) had eggs scattered over the entire length of the main trunk. The 50,000 or more eggs of *A. pomi* used in the various experiments were collected from young orchards in the northern section of the state near Lyons and Chester. The eggs of *A. sorbi* were not plentiful in any of the orchards examined this past year. A large number of orchards were observed during October, November and December, 1918, and wherever *A. sorbi* was seen the insects were few in number compared with *A. avenæ* which was always present. The scarcity of *A. sorbi* made it impractical to conduct experiments with this species.

The great abundance of *A. avenæ* this year made it possible to observe the injury done by this species. Where *A. avenæ* was the only species present on a tree it was noted that comparatively few of the leaves were curled even though the undersides of the leaves might have a large number of aphides on them. In contrast to this it was noted that whenever *A. sorbi* or *A. pomi* was present, even in small numbers (2 to 6), the leaves were badly curled and stunted. All three species were also found in large numbers on the petioles of the flowers in the pink bud and flower stage and it is probable that they may injure the set of the fruit. It is a well known fact that *A. sorbi* causes clusters of small distorted fruit but, so far as known, this is not true of *A. avenæ.* The stem mothers of *A. avenæ* give rise to nymphs, the majority of which develop wings and these migrate to other plants, thus disappearing almost completely by May 15 to 30. *A. sorbi* continues to live on the apple plant for several generations (3 to 4) and does not completely disappear from the apple tree until the last of June, while *A. pomi* lives on the apple tree the entire year.

The observations made this season indicate that the injury caused by *A. avenæ* is not serious under ordinary conditions; consequently if

this is the only species present in the orchard a great amount of injury will not take place. The only way to be sure *A. sorbi* and *A. pomi* are not present is to make a careful determination of the adult forms during the fall of the year. Observations made at this time will give one a fair estimate as to what species will be troublesome in the spring. Careful examinations of numerous orchards throughout the state for three years during October, November and December, has shown that where aphides are present 75 per cent or more of infested orchards possess some or many adults of *A. sorbi*. The black shiny eggs of *A. sorbi* and *A. avenæ* resemble each other and they are deposited by the female in similar situations (usually on the second year wood), consequently it is impossible to distinguish the two species during the dormant season. The first nymphs to hatch in the spring are *A. avenæ* (usually at the time when the fruit buds first show green) and these may be distinguished from *A. sorbi* and *A. pomi* which hatch 10 to 14 days after *A. avenæ*. In New Jersey the eggs of *A. sorbi* and *A. pomi* hatch too late to safely or satisfactorily apply a delayed dormant spray of lime-sulfur and nicotine during or after the eggs of these species have hatched. Consequently it is not advisable to wait until the hatching period of *A. sorbi* and *A. pomi* has passed in order to determine the presence of the injurious species and then attempt to obtain a satisfactory control.

The above facts concerning plant lice eggs on apple trees leads to the conclusion that it is highly advisable to apply a delayed dormant spray if aphid eggs are found on the trees, during the dormant season. If one has made a careful examination of the adult forms during October, November and December, and is certain that *A. avenæ* is the only species present, it might be safe to ignore the presence of the aphid eggs on apple trees.

Morphology and Behavior of the Eggs

Observations on the morphology and the behavior of aphid eggs were repeated this past season and it was again observed that the eggs of *A. avenæ* and *A. pomi* (for observations on *A. sorbi* see N. J. Agr. Expt. Sta. Bull. 332) show two distinct layers in the egg shell, an outer, semi-transparent layer which is soft and glutinous when the egg is deposited, and an inner soft elastic membraneous black layer. After the egg is deposited the outer layer hardens and becomes somewhat tough and impervious upon long exposure to weather. A third layer or skin may be seen about the nymph when it emerges. This is an embryonic membrane or the first exuvium. It is shed by *A. avenæ* when the nymph is half-way out of the shell, while with *A. pomi* it is not shed until the nymph is practically free from the entire

egg. The egg burster or elevated ridge on the meson of the cephalic aspect of the head in both species disappears at the time the skin or exuvium splits and is shed, consequently it must be a part of the embryonic membrane or exuvium.

In both species the outer layer of the egg usually splits along the dorso-mesal line a number of days before the nymph emerges. This splitting of the outer layer of the egg is also characteristic of eggs of other species of plant lice. A number of undetermined eggs of plant lice found on various trees (willow, etc.) were examined during March and their outer layers split in a manner similar to aphid eggs found on apple trees. If aphid eggs in general are similar in construction and behavior in hatching to aphid eggs on apple trees then the response of various species of aphid eggs to environmental factors might be the same. Under these conditions it is probable that evaporating factors have considerable influence on the percentage of hatch. During the past season at New Brunswick the first eggs of *A. avenæ* with a split outer shell were seen on February 10. The percentage of eggs of *A. avenæ* showing this split condition continued to increase and when the eggs started to hatch in large numbers on March 21, 35 to 40 per cent of the eggs showed a split outer shell and from 60 to 65 per cent of the eggs hatched in 1919.

The hatching period during 1919 lasted from March 21 until April 6. This prolonged period was due to the fact that on March 28, when 55 per cent of the eggs had hatched, a decided drop in the temperature took place and this continued for five or six days, thus delaying the completion of the hatching until April 3 to 5.

The first eggs of *A. pomi* at New Brunswick with a split outer covering were seen on March 3 and on March 21, 25 to 35 per cent had split their outer shells. *A pomi* started to hatch rapidly between April 5 and 10 and the hatching period was completed by April 20. From 50 to 55 per cent of the eggs of this species hatched in 1919. The eggs of this species were found on first year wood and collected from a young apple orchard near Lyons and Chester, N. J. It is possible that a few of them, not over 10 per cent, were eggs of *A. avenæ* and *A. sorbi*. On April 22, the particular trees at Lyons from which the majority of eggs were collected for experimental purposes were examined and the young leaves were covered with aphides. After observing several hundred insects, 4 per cent were *A. avenæ*, 7 per cent were *A. sorbi*, and 89 per cent were *A. pomi*. Even though this count is correct it is probable that many of the nymphs of *A. avenæ* and *A. sorbi* seen on the terminal fruit buds came from eggs located on the second year wood (second year wood was not used in experiments with *A. pomi*).

Methods

Whenever material was needed for experimental purposes, collections were made from the above mentioned orchards and the material was kept out-of-doors all the time and exposed to all conditions of the weather except for the few minutes required to examine the eggs under a binocular microscope in order that all the abnormal appearing eggs (shriveled, hatched or light colored eggs) might be removed and the normal eggs counted. A string tag was placed on each twig (8 to 12 inches long) and on it was written the number of the experiment, total number of normal eggs, species, and source of the material.

The number of normal eggs of *A. avenæ* and *A. pomi* used in each spraying experiment in 1918–1919 was 200 to 300 and 300 to 500, respectively, while in 1917–1918 only 100 to 150 eggs were used. This increase over previous years reduced the possibility of experimental error to a minimum. The consistent regularity of the plotted lines on the charts shows the minimum nature of the experimental error in the spraying experiments for 1918–1919. The eggs of *A. avenæ* were sprayed at regular intervals throughout the season; on December 7, 1918, January 9, February 10, March 1, March 10 and March 21, 1919, while the eggs of *A. pomi* were sprayed on February 18, March 3, March 12 and March 21, 1919. No dormant sprays were applied after March 21 because at that time the fruit buds showed green and were in the proper stage for the application of a delayed dormant spray. Any recommended dormant spray applied after April 3 in the southern part of New Jersey in 1919 would have injured most varieties of apple trees. Furthermore, many hatched nymphs after April 3 were protected by the young leaves.

The following substances were used at varying strengths and some in combination with each other in the spraying experiments: concentrated liquid lime-sulfur (Mechling Bros. Mfg. Co., Camden, N. J.), dry lime-sulfur (The Sherwin-Williams Co., Newark, N. J.), barium-sulfur ("B. T. S.," General Chemical Co., New York City), sodium-sulfur ("Soluble sulphur," Niagara Sprayer Co., Middleport, N. Y.), sodium sulfo-carbonate (The Dow Chemical Co., Midland, Mich.), hydrated lime, miscible oil ("Scalecide," B. G. Pratt Co., New York City), nicotine ("Black Leaf 40," The Kentucky Tobacco Product Co., Louisville, Ky.), fish oil soap, paste form (Capstone Mfg., Newark, N. J.), "Fels Naphtha" laundry soap, linseed oil, cotton seed oil crude carbolic acid, cresol U. S. P., etc. All of the sprays were applied to the twigs by means of a small hand atomizer connected with a foot pump. The twigs were held several inches from the tip of the atomizer and all sides of each twig were thoroughly hit once, thus coating every egg. After all the twigs of one experiment were sprayed they were

tied together and then suspended in a perpendicular position on two wires which ran across the upper portion of a large empty wooden box. The large boxes were located out-of-doors in an open spot near the laboratory, and thus the twigs were exposed to all weather conditions, similar to that of the orchard. The above laboratory method of spraying and caring for the eggs is somewhat ideal, yet the results obtained for the past three seasons have been very satisfactory in ascertaining the exact effect of each spray and their comparative values. The results of this laboratory method have exactly duplicated the results obtained in the orchard where lime-sulfur 1–9, lime-sulfur 1–9 plus nicotine 1–500 and "Scalecide" 1–15 have been used. During 1918–1919 the above out-of-door laboratory method for determining the value of various sprays in killing the eggs has been relied upon almost entirely. In several orchards a few observations were made on the effect of lime-sulfur, 1–9 plus nicotine, 1–500 and the results corresponded with results of similar experiments at the laboratory.

Contact Sprays

Previous morphological and ecological studies on the eggs of plant lice found on apple trees show conclusively that they may be killed by various contact sprays. It has been shown that the eggs are most susceptible to environmental factors and various chemicals just previous to the hatching period. The period of susceptibility commences about the first week in March with *A. avenæ* and probably a week or ten days later with *A. pomi.* At this time the eggs are commencing to rapidly split their outer coats. The maximum susceptibility of the majority of the eggs probably occurs just at the time the eggs are starting to hatch in large numbers because at this stage the largest percentage have split their outer shells preparatory to severing the inner black membrane. This season's results indicate that the susceptibility of the eggs of *A. avenæ* and *A. pomi* to various sprays are approximately the same while observations made in 1917 indicate that the eggs of *A. sorbi* and *A. pomi* are somewhat more resistant to various sprays than eggs of *A. avenæ.* Undoubtedly the different sprays act on the eggs in various ways. Some may act as desiccators (probably lime-sulfur and others) which harden the outer shell more or less or extract the water content from the embryo (especially if applied after the outer layer has split). Other substances soften and disintegrate the outer highly impervious layer (crude carbolic acid), thus exposing the inner layer to evaporating factors. The physical reaction of contact insecticides may be important, but it is probable that the toxic effect of various insecticides upon the embryo is much more important. This is a point that is diffcult to determine.

Table I. Percentages of Hatch (Selected Eggs of A. avenæ Kept Out-of-Doors) When Eggs were Coated with Contact Sprays on December 7, 1918, January 9, February 10, March 1, March 10 and March 21, 1919 (200–300 Eggs in Each Trial)

Plotted Expts. on Charts	Serial Number	Spray	Sprayed December 7, 1918	Sprayed January 9, 1919	Sprayed February 10, 1919	Sprayed March 1, 1919	Sprayed March 10, 1919	Sprayed March 21, 1919
a	1	Liquid lime-sulfur, 1–9	31	17	8	7	6.7	6.2
b	2	Liquid lime-sulfur, 1–6	28	13	8	1	0.6	4.6
c	3	Liquid lime-sulfur, 1–9 plus casein-lime, 1 gm.–100 cc.	25	10	6	1.5	0	1.7
d	4	Liquid lime-sulfur, 1–6 plus casein-lime, 1 gm.–100 cc.	21	11	3	1.7	0	1
	5	Dry lime-sulfur (S-W), 10 lb.–50 gal.			38	49	12	24
e	6	Dry lime-sulfur (S-W), 15 lb.–50 gal.			39	35	22	25
f	7	Dry lime-sulfur (S-W), 20 lb.–50 gal.			37	23	11	8
g	8	Dry (dust form) lime-sulfur (S-W), 15 lb.–50 gal.			36	20	10	8
	9	"B. T. S.," 10 lb.–50 gal.			36	34	30	24
h	10	"B. T. S.," 15 lb.–50 gal.			33	21	11	15
	11	"B. T. S.," 20 lb.–50 gal.			41	12	10	8.5
i	12	"Soluble sulfur," 15 lb.–50 gal.			29	12	16	6.7
	13	Liquid sodium sulfo-carbonate, 1–9					[1]1.5	1.7
	14	Liquid sodium sulfo-carbonate, 1–14						1.0
	15	Liquid sodium sulfo-carbonate, 1–19						7
j	16	Liquid lime-sulfur, 1–9 plus nicotine, 1–500	6	7	6	0	1	0
k	17	Liquid lime-sulfur, 1–6 plus nicotine, 1–500	0.6	6	3	0	0	0
l	18	Liquid lime-sulfur, 1–9 plus casein-lime, 1 gm.–100 cc. plus nicotine, 1–500	0	4	4	0	0	0
m	19	Liquid lime-sulfur, 1–6 plus casein-lime, 1 gm.–100 cc. plus nicotine, 1–500	0	2	2	0	0	0
	20	Dry lime-sulfur (S-W), 10 lb.–50 gal. plus nicotine, 1–500			25	0	6.5	3
n	21	Dry lime-sulfur (S-W), 15 lb.–50 gal. plus nicotine, 1–500			18	1	0.9	1.5
	22	Dry lime-sulfur (S-W), 20 lb.–50 gal. plus nicotine, 1–500			7	0	0.5	1.4
o	23	Dry (dust form) lime-sulfur (S-W), 15 lb.–50 gal. plus nicotine 1–500			9	2	0.9	1.4
	24	"B. T. S.," 10 lb.–50 gal. plus nicotine, 1–500			8	2	0.9	9
p	25	"B. T. S.," 15 lb.–50 gal. plus nicotine, 1–500			17	1	0.0	2.4
	26	"B. T. S.," 20 lb.–50 gal. plus nicotine, 1–500			12	0	0.5	0

[1] Sprayed March 18, 1919.

Table I.—*Concluded*

Plotted Expts. on Charts	Serial Number	Spray	Sprayed December 7, 1918	Sprayed January 9, 1919	Sprayed February 10, 1919	Sprayed March 1, 1919	Sprayed March 10, 1919	Sprayed March 21, 1919
q	27	"Soluble sulfur," 15 lb.–50 gal. plus nicotine, 1–500			5	2.6	0.0	0.9
	28	Liquid sodium sulfo-carbonate, 1–9 plus nicotine, 1–500					[1]0.3	0.0
r	29	Hydrated lime, 1.75 gm.–50 cc.		70	58	42	26	20
	30	Hydrated lime, 1.75 gm.–50 cc. plus casein-lime, .25 gm.–50 cc.		67	58	25	30	17
	31	Hydrated lime, 3.5 gm.–50 cc.		55	44	44	19	26
s	32	Hydrated lime, 3.5 gm.–50 cc. plus casein-lime, 0.5 gm.–50 cc.		49	48	31	13	17
u	33	Fish-oil soap, 1 gm.–50 cc.			64	62	48	15
v	34	Fish-oil soap, 1 gm.–50 cc. plus nicotine, 1–500	48	55	19	23	16	1.1
	35	Fish-oil soap, 1 gm.–100 cc. plus nicotine, 1–500	50	60	50	58	31	2
y	36	Fish-oil soap, 1 gm.–50 cc. plus crude carbolic acid, 2 cc.–98 cc.		58	56	45	22	2.8
	37	Crude carbolic acid, 2 cc.–98 cc.		67	56	71	58	10
t	38	"Scalecide," 1–15	42	52	36	23	27	9
	39	"Scalecide," 1–15, plus soap, 1 gm.–200 cc.			35	33	32	12
	40	"Scalecide," 1–25 plus soap, 1 gm.–200 cc.			45	50	46	24
z	41	Linseed Oil, 8 cc.–92 cc. plus laundry soap, 1 gm.–100 cc.			50	33	36	6
	42	Linseed Oil, 8 cc.–92 cc. plus laundry soap, 1 gm–100 cc. plus crude carbolic acid, 1 cc–99 cc.			66	39	35	1
z-2	43	Cotton-seed oil, 8cc.–92cc. plus laundry soap, 1 gm.–100 cc.			68	52	46	8
	44	Cotton-seed oil, 8 cc.–92 cc. plus laundry soap, 1 gm.–100 cc. plus crude carbolic acid, 1 cc.–99 cc.			40	46	30	6
	45	Checks (300–500 eggs in each)	72	75	75	60	61	62
		Percentage of eggs showing a split in outer shell	0	0	1	3–8	15–20	35–40

[1] Sprayed March 18, 1919.

The purpose of this past season's spraying experiments has been to repeat all the experiments of previous years which give some promise of becoming important sprays for the control of aphides in the egg stage; to determine the comparative value of recommended (and other) winter strengths of concentrated liquid lime-sulfur, dry (coarse and fine powder) lime-sulfur, barium-sulfur ("B. T. S.") and sodium sulfur

("Soluble sulphur"), each by itself and each in combination with nicotine (Black Leaf 40, 1–500); to try out various other sprays and combinations and also to make a preliminary determination of the value of spreaders for any contact insecticide which might be used to kill aphid eggs.

The results of the majority of the spraying experiments for 1918-1919, with the eggs of *A. avenæ* and *A. pomi*, may be found in Tables I and II respectively. The two tables show for every spray the serial number, the letter representing the spray on the charts (if plotted) and the dates of application. The numbers to the right of each spray are the percentages of hatch of 200 to 500 eggs sprayed on the dates indicated at the top of each column. The spray solutions were made up in liter quantities or fractions thereof (100 cc.). A solution reading as follows: linseed oil 8 cc.–92 cc. plus laundry soap 1 gm.–100 cc. plus crude carbolic acid 1 cc.–99 cc. means that in 100 cc. of the spray mixture there is 8 cc. of linseed oil, 1 gm. of soap and 1 cc. of crude carbolic acid. The same thing is true with all other sprays represented in the tables.

The most important series of experiments have been plotted in Charts I–V. Each spray has been given a definite letter which is the same for all the charts. The key on page 381 or the letters in the first column of Tables I and II show what each letter stands for. The charts show on the top line the date of application, while the columns of figures to the left and right indicate the percentage of hatch and the percentage of kill, respectively. The point of intersection of the plotted lines with the perpendicular date lines (date of application) indicates the percentage of hatch if one examines the column of figures to the left and the percentage of dead eggs if one examines the column of figures to the right. The percentage figures at the bottom of the chart show the approximate percentage of eggs with a split outer shell on the respective dates when the applications were made.

The majority of plotted experiments show a gradual and regular increase in effectiveness from the first applications made in December, January and February to the last made on March 21, 1919. In a few series of experiments and in the checks as well there is some irregularity. This irregularity may be due to the fact that occasionally one may work with a few abnormal eggs and still not be aware of it at the time when the spray is applied. The use of a large number of eggs in each experiment and the fact that collections were made from various trees in the same orchard largely eliminates the possibility of serious experimental error. In Charts II and III it will be noted that on March 21 some of the experiments show a slight increase in the percentage of hatch where applications were made on this date. This

Table II. Percentages of Hatch (Eggs of A. pomi Kept Out-of-Doors) when Eggs were Coated with Contact Sprays on February 18, March 3, March 12 and March 21, 1919. (300–500 Eggs in Each Trial)

Plotted expts. on chart 5	Serial Number	Spray	Sprayed February 18, 1919	Sprayed March 3, 1919	Sprayed March 12, 1919	Sprayed March 21, 1919
a	1-p	Liquid lime-sulfur, 1–9	14	11	7	4
b	2-p	Liquid lime-sulfur, 1–6	10	3.7	4.3	0.5
	3-p	Liquid lime-sulfur, 1–9 plus casein-lime, 1 gm.–100 cc.			3.1	0
e	4-p	Dry lime-sulfur (S-W), 15 lb.–50 gal.	15	15	20	9
	5-p	Dry (dust form) lime-sulfur (S-W), 15 lb.–50 gal.				6
h	6-p	"B. T. S.," 15 lb.–50 gal.	18	20	10	12
i	7-p	"Soluble sulphur," 15 lb.–50 gal.	8.5	16	15	8.3
	8-p	Liquid sodium sulfo-carbonate, 1–9				0
j	9-p	Liquid lime-sulfur, 1–9, plus nicotine, 1–500	3.7	2.8	0	1.6
k	10-p	Liquid lime-sulfur, 1–6 plus nicotine, 1–500	2.7	0	0	0
	11-p	Dry lime-sulfur (S-W), 15 lb.–50 gal. plus nicotine, 1–500				2
	12-p	Dry (dust form) lime-sulfur (S-W), 15 lb.–50 gal., plus nicotine 1–500				0
	13-p	"B. T. S.," 15 lb.–50 gal. plus nicotine, 1–500				0
	14-p	"Soluble sulphur," 15 lb.–50 gal. plus nicotine, 1–500				0
	15-p	Liquid sodium sulfo-carbonate, 1–9 plus nicotine, 1–500				0
	16-p	Fish-oil soap, 1 gm.–50 cc.			33[1]	8
	17-p	Fish-oil soap, 1 gm.–50 cc. plus nicotine, 1–500				3
w	18-p	Fish-oil soap, 1 gm.–100 cc. plus nicotine, 1–500	44	33	28	13
	19-p	Fish-oil soap, 1 gm.–50 cc. plus crude carbolic acid, 2 cc.–98 cc.				13
	20-p	Crude carbolic acid, 2 cc.–98 cc.	61	44	62	15
t	21-p	"Scalecide," 1–15	41	35	14	12
	22-p	"Scalecide," 1–15 plus laundry soap, 1 gm.–200 cc.		11	20	1
	23-p	"Scalecide," 1–25 plus laundry soap, 1 gm.–200 cc.			23	23
	24-p	Linseed Oil, 8 cc.–92 cc. plus laundry soap, 1 gm.–100 cc.			20	9
	25-p	Linseed Oil, 8 cc.–92 cc. plus laundry soap, 1 gm.–100 cc. plus crude carbolic acid, 1 cc.–99 cc.				3.5
	26-p	Cotton-seed oil, 8 cc.–92 cc. plus laundry soap, 1 gm.–100 cc.			14	10
	27-p	Cotton-seed oil, 8 cc.–92 cc. plus laundry soap, 1 gm.–100 cc. plus crude carbolic acid, 1 cc.–99 cc.				8
	28-p	Check	60	62	62	47
		Percentage of eggs showing a split in outer shell	0	1–5	5–15	25–35

[1] Fish-oil soap, 1 gm.–100 cc. of water.

increase is probably an experimental error. The eggs started to hatch rapidly on March 21 and it was necessary to reëxamine each twig before it was sprayed in order to remove or count all hatched eggs. Under these conditions, when it was necessary to work rapidly, it is possible that some of the hatched eggs or eggs where the nymphs had just severed the inner pigmented membrane, were overlooked.

Chart I shows the results of some spraying experiments with the eggs of *A. avenæ* for the season of 1917–1918. Comparing the lines in this chart with those of similar experiments on Charts II, III and IV (spraying experiments with the eggs of *A. avenæ* for 1918–1919), there is a decided similarity in the comparative value of various sprays in killing the eggs of *A. avenæ* for the two seasons. In a few series of experiments for the two seasons there is a marked difference in the angle at which the lines of various plotted experiments cross the chart. In the 1918–1919 charts the lines are more nearly perpendicular due to the fact that 65 to 70 per cent of the selected eggs in the checks of *A. avenæ* hatched in 1919, while in 1918 only 45 to 50 per cent hatched. This difference is especially noticeable with sprays which produce little or no effect on the eggs when applied during December, January or February (Expt. t, u, and v).

Liquid and Dry Lime-Sulfur and Substitutes

Concentrated liquid lime-sulfur at the recommended winter strength, 1–9 (or 1–6) is superior to all other sprays (when used at their respective recommended strengths) in killing the eggs of apple plant lice. Applications of lime-sulfur, 1–9 made during March, 1919, killed 92 to 94 per cent of all the eggs of *A. avenæ* and 89 to 96 per cent of all the eggs of *A. pomi* (Table I and II and Charts I–V). Lime-sulfur, 1–6 is somewhat superior to 1–9, but in no instance did it bring about a complete kill. Casein-lime, 1 gm.–100 cc. added to lime-sulfur seems to materially increase the effectiveness of both strengths of lime-sulfur, killing 98 to 100 per cent during March. The casein-lime used as a spreader was composed of fifty per cent casein (lactic) and fifty per cent hydrated lime.

Lime-sulfur in a dry state, commercially known as dry lime-sulfur, was given a thorough try out and in all cases where it was used (Expt. 5, 6, 7 and 8, Table I and Expt. 4-p, and 5-p Table II) at the rate of 10, 15 and 20 pounds to 50 gallons of water the percentage of kill of the eggs of *A. avenæ* and *A. pomi* was decidedly below that of concentrated liquid lime-sulfur, 1–9. For dormant spraying the manufacturers (Sherwin-Williams Co.) recommend 10 to 14 pounds to 50 gallons of water. At the rate of 15 pounds to 50 gallons the greatest percentage of kill of the eggs of *A. avenæ* was 78 per cent while 94 per

cent were killed with concentrated lime-sulfur, 1–9 (see Charts II and V).

Dry lime-sulfur may be secured in two forms, a coarse powder which is recommended for liquid spraying and a finely ground powder which is suitable for dusting. The two forms behave differently when dissolved in water. Using amounts (thoroughly dried) equivalent to 14 pounds to 50 gallons of water only 65 to 67 per cent of the coarse product dissolved in water in thirty minutes (thoroughly agitated) while 88 per cent of the fine powder dissolved under the same conditions. In other tests similar to the above, except for the fact that the residue in the filter was thoroughly washed, 74.2 per cent of the coarse form dissolved while 90.3 per cent of the fine powder dissolved. The insoluble character of dry lime-sulfur, particularly the coarse form, is undoubtedly objectional. To be most effective in spreading and as a contact insecticide all the lime-sulfur should be soluble. A chemical analysis of dry lime-sulfur shows approximately 55 per cent sulfur in the dry product. When this product is used at the recommended winter strength, 14 pounds to 50 gallons of water, figures show that the spray, as it goes to the tree, contains approximately 50 per cent as much sulfur per gallon as the recommended liquid lime-sulfur 1–9.

The poor soluble character of dry lime-sulfur and the low sulfur content of the recommended winter strength probably explains its low efficiency in killing aphid eggs when compared with the recommended winter strength of concentrated liquid lime-sulfur. The soluble character of the dry lime-sulfur is undoubtedly important for the superior efficiency of the higher soluble dust form over the lower soluble coarse form is clearly illustrated in Chart II, lines e, f, and g (e = coarse lime-sulfur, 15 lbs. to 50 gals.; f = coarse dry lime-sulfur, 20 lbs. to 50 gals.; g = dust form dry lime-sulfur, 15 lbs. to 50 gals.). Lines f and g approximately coincide and are considerably above line e. This indicates that 20 pounds to 50 gallons of the coarse dry lime-sulfur nearly equals the killing efficiency of 15 pounds to 50 gallons of the dust form.

A few dusting experiments (eggs of *A. avenæ* on March 7, 1919) were tried with dry lime-sulfur (dust form) alone, hydrated lime alone and a combination of one part dry lime-sulfur and one part hydrated lime. The twigs were thoroughly covered and then placed out-of-doors (as in other experiments). The eggs coated with dry lime-sulfur showed a 28 per cent hatch; with hydrated lime, a 48 per cent hatch, and with a combination of dry lime-sulfur and hydrated lime, a 30 per cent hatch. The results of these few dusting experiments indicate that the efficiency of dry lime-sulfur applied as a dust is considerably less than when the dry lime-sulfur (dust form, 15 pounds to 50 gallons) is applied as a liquid spray.

Barium sulfur, largely barium tetra sulphide, commercially known as "B. T. S." was given the same liquid spray tests as dry lime-sulfur (Tables I and II and Charts II, III and V). Where "B. T. S." was used at the rate of 15 pounds to 50 gallons, the killing or efficiency (eggs of *A. avenæ*) is somewhat superior to that of coarse dry lime-sulfur at the same strength, but is decidedly inferior to concentrated liquid lime-sulfur, 1–9 (Charts II and V, line h). "B. T. S." 20 pounds to 50 gallons comes nearer being equal to concentrated liquid lime-sulfur. "B. T. S." is highly soluble in water, 98.1 per cent at the recommended winter strength of 14 pounds to 50 gallons of water. The sulfur content per gallon of the recommended dormant spray of "B. T. S." as it goes on the tree is approximately 50 per cent that of concentrated liquid lime-sulfur, 1–9.

Sodium-sulfur, largely sodium polysulphide, commercially known as "Soluble Sulphur," was experimented with at the rate of 15 pounds to 50 gallons of water. This dry substitute for concentrated lime-sulfur proved to be the most efficient in killing the eggs of *A. avenæ*, yet in no instance did it equal that of concentrated liquid lime-sulfur," 1–9 except on March 21, 1919, when its efficiency was approximately the same (Chart II and V, line i). "Soluble Sulphur" is very caustic and also highly soluble (98.5 per cent soluble) at the rate of 14 pounds to 50 gallons of water. A quantative analysis of the recommended dormant strength of "soluble sulfur" as it goes on the tree shows approximately 50 per cent as much sulfur per gallon as concentrated liquid lime-sulfur, 1–9.

Nicotine

In all the spraying experiments with the eggs of *A. avenæ* and *A. pomi*, the addition of nicotine always increased the killing efficiency of every spray. This is particularly true when nicotine,1–500 was added to concentrated liquid lime-sulfur, 1–6 or 1–9 (j, k, 1 and m, Chart III), to dry (coarse or dust form) lime-sulfur, 10, 15 or 20 pounds to 50 gallons (n and o, Chart III), to barium-sulfur ("B. T. S."), 10, 15 and 20 pounds to 50 gallons (p, Chart III), and to sodium-sulfur ("Soluble sulphur"), 15 pounds to 50 gallons (q, Chart III). Chart III shows the results of a series of experiments with one or more strengths of each of the above substances plus nicotine, 1–500. Comparing Chart II with Chart III spray lines a = j, b = k, c = l, d = m, e = n, g = o, h = p, and i = q, except for the addition of nicotine 1–500 in j, k, l, m, n, o, p, and q. All of the experiments seen on Chart III show a percentage of kill running between 97 and 100 per cent when the combined spray is applied on March 1, March 10, and March 21. On these same dates all of the concentrated liquid lime-sulfur sprays

1–6 or 1–9 (with and without casein-lime) combined with nicotine 1–500 show 100 per cent kill except one application of lime-sulfur 1–9 plus nicotine, 1–500 (j) made on March 10 (99 per cent kill). Chart V, where the eggs of *A. pomi* were used in all the experiments, also shows an increase in the efficiency of a combined spray of lime-sulfur and nicotine over lime-sulfur alone (a, b, j, and k, Chart 5).

Nicotine added to fish-oil soap also increased its efficiency (Exp. 33, 34, 35, Table I and Expt. 16-p, 17-p, 18-p, Table II or Charts I, IV and V). A combination of fish-oil soap, 1 gm.–50 cc. and nicotine, 1–500 kills 99 per cent of the eggs of *A. avenœ,* when applied on March 21, but earlier applications of the same spray are decidedly inefficient. Nicotine was also added to "Scalecide" 1–15, 1–25 and 1–40 in a few experiments on March 18 (not shown in tables) and the efficiency of the spray was increased 20 to 30 per cent, but in no case was there a complete kill. The best combination proved to be "Scalecide," 1–15 plus nicotine, 1–500 which killed 98 per cent of the eggs of *A. avenœ.* Nicotine was also added to varying strengths of linseed and cotton-seed oil emulsions (2 cc.–8 cc. to 98 cc.–92 cc. respectively, plus laundry soap 1 gm.–100 cc.) but with both oils a reaction occurred which caused the two oils to form large globules that came to the surface at once. This was probably due to the fact that the oil solutions gave an acid reaction. This material was difficult to spray and the efficiency of the combined spray was only increased slightly (Expts. not recorded in table). Nicotine, 1–500 added to sodium sulfo-carbonate 1–9 gave almost complete control (99.7 and 100 per cent) when sprayed on March 18 and March 21 on the eggs of *A. avenœ* and *A. pomi* (see Tables I and II). It is probable that this substance may prove to be as efficient as concentrated liquid lime-sulfur, 1–9 in killing the eggs of *A. avenœ,* however, its effect upon plants particularly green swollen buds is unknown. A few experiments at the laboratory indicate that it would be unsafe to use the above strength on green tissue.

Other Sprays and Chemicals

In addition to the foregoing experiments a large number were conducted, particularly on the eggs of *A. avenœ,* with varying strengths of sodium sulfo-carbonate, hydrated lime, "Scalecide," crude carbolic acid and cresols, fish-oil soap, linseed oil emulsions and cotton-seed emulsions. Some of the more important of these may be found in Tables I and II and on Charts I, IV, and V, but the results of a large number of them are not included in the tables or on the charts in this paper. Each substance will be discussed separately and the significant points brought out.

Sodium sulfo-carbonate chemically known by the formula Na^2CS^3 and also called sodium thiocarbonate was manufactured for Dr. T. J. Headlee three years ago by the Dow Chemical Co., Midland, Mich. The material was tightly sealed in bottles and had partially crystalized when used this season, but the application of a small amount of heat soon melted the crystals. In a few experiments (Expt. 13, 14, 15, 20, Table I and Expt. 8-p, 15-p, Table I, etc.) performed on March 18 and 21 with the eggs of *A. avenæ* and *A. pomi* a 1–9 dilution killed 98 to 100 per cent, a 1–14 dilution killed 79 to 99 per cent, and a 1–19 dilution killed 93 per cent. In a similar lot of experiments ordinary laundry soap (1 gm.–200 cc.) was added with no apparent change in the solution and the percentages of kill with the various strengths (1–9, 1–14, and 1–19) were almost identical with the experiments where no soap was used. Fish-oil soap at varying strengths (1 gm.–50 cc., 1 gm.–100 cc. and 1 gm.–200 cc.) was used with each of the three dilutions (1–9, 1–14, and 1–19) of sodium sulfo-carbonate and in every case the percentage of kill was materially reduced rather than increased as we would expect. Some change probably takes place in the solution when the fish-oil soap is added and this lowers its efficiency. A slight precipitate was formed when a strong solution of fish-oil soap (1 gm.–50 cc.) was used. The above experiments with sodium sulfo-carbonate indicate that it is very efficient in killing aphid eggs. It is worthy of further investigation.

Hydrated lime in a finely divided state was applied in a liquid spray throughout the season on the eggs of *A. avenæ* (Expt. 29, 30, 31, and 32, Table I) in two strengths (1.75 gm.–50 cc. and 3.5 gm.–50 cc.) with and without the addition of casein-lime (lactic). In no experiment with lime by itself did the percentage of kill run over 81 per cent and in most cases it was far below this point. Where casein-lime was added there was a slight increase in the percentage of kill. This is probably due to the fact that the particles of lime become more evenly distributed if casein is present. The addition of casein-lime made a decided increase in the length of time the lime would remain in suspension. Ordinary hydrated lime mixed with water settles immediately unless constantly agitated. Hydrated lime was dusted onto the eggs of *A. avenæ* on March 7, 1919, and 48 per cent of the eggs hatched.

"Scalecide," a miscible oil, was given another thorough tryout this season and again the results clearly demonstrate that such an oil at the recommended winter strength, 1–15 does not kill a sufficient quantity of eggs to make it a practical spray for the control of aphis in the egg stage. The greatest percentage of kill was 91 per cent with *A. avenæ* and 88 per cent with *A. pomi* when the eggs were sprayed on

March 21. Other applications at the same strength applied earlier in March and throughout the season show a much lower percentage of kill, some as low as 48 per cent (Expts. 38, 39 and 40, Table I, Expt. 21-p, 22-p and 23-p, Table II). Three years of careful study at the laboratory and in the orchard convinces us that this miscible oil is not an efficient agent for killing eggs of plant lice occurring on apple trees.

Crude carbolic acid and various cresols used in different experiments in 1917–1918 were again used during the past season on the eggs of *A. avenæ* and some on the eggs of *A. pomi*. A 2 per cent solution of crude carbolic acid (Expt. 36, and 37, Table I and Expt. 19-p, 20-p, Table II) was applied on the eggs of *A. avenæ* and *A. pomi* at regular intervals. The percentage of kill was not very great in any application except on March 21 when the acid killed 90 per cent of the eggs of *A. avenae* and 85 per cent of the eggs of *A. pomi*. Altogether this season's results with crude carbolic acid show a smaller percentage of kill than in 1918. Crude carbolic acid (2 gm.–98 cc.) was also combined with fish-oil soap (paste form) 1 gm.–50 cc. and sprayed on the eggs of *A. avenæ* at regular intervals. This combination killed the greatest percentage of eggs on March 21, 97.2 per cent of *A. avenæ* and 87 per cent of *A. pomi*. All applications of this combination before March 21 permitted 22 to 58 per cent of the eggs to hatch. The addition of fish-oil soap helps materially to increase the efficiency of the carbolic acid mixture, yet the results are by no means sufficiently satisfactory for practical use in orchard spraying. It is also probable that a 2 per cent solution of crude carbolic would injure green swollen fruit buds, if one waited until the eggs were most susceptible to sprays. On March 7, 1919, a large number of experiments were conducted on the eggs of *A. avenæ* with 1 and 2 per cent solutions of crude carbolic acid, cresol U. S. P., phenol c. p., ortho cresol c. p., meta cresol c. p., and para cresol c. p. and the results were similar to those of 1917–1918. Crude carbolic acid was somewhat superior to all. No spray killed over 60 per cent of the eggs.

Fish-oil soap at the rate of 1 gm.–50 cc. of water was sprayed on the eggs of *A. avenæ* on February 10, March 1, March 10 and March 21, and the greatest kill, 85 per cent, took place on March 21. The same strength was sprayed on the eggs of *A. pomi* on March 21, 1919, and it killed 92 per cent. The percentage of kill of the eggs of *A. avenæ* with this same strength of soap and applied previous to March 21 was 36 to 52 per cent. Fish-oil soap at different strengths was also combined with various sprays (discussed under separate sprays).

Linseed and cotton-seed oil at strengths varying from 2 to 8 per cent of the solution were thoroughly emulsified with laundry soap

and fish-oil soap (1 gm.–200 cc., 1 gm.–100 cc. and 1 gm.–50 cc.) and given a thorough tryout. A series of interesting results were obtained, but none of these gave a satisfactory control. In most instances linseed oil at a given strength was somewhat more efficient in killing eggs than cotton-seed oil. The greatest strength used gave the highest percentage of kill. Where linseed oil (Expt. 41, Table I; Expt. 24-p, Table II) was used at the rate of 8 cc.–92 cc. of soap solution (laundry soap, 1 gm.–100 cc.) it killed 94 per cent of the eggs of *A. avenæ* and 91 per cent of *A. pomi* when applied on March 21. Where applications were made on March 10 or previous to this the greatest percentage of kill was 64 per cent or less. Where cotton-seed oil was used at the rate of 8 cc. to 92 cc. of soap solution (laundry soap 1gm.–100 cc.) it killed 92 per cent of the eggs of *A. avenæ* and 90 per cent of the eggs of *A. pomi* when applied on March 21. Where applications were made on March 10 or before the percentage of kill was 54 per cent or less. Crude carbolic acid at the rate of 1 gm. to 100 cc. of spray was added to linseed and cotton-seed oil sprays and in the majority of cases there was a slight reduction in the percentage of hatch over the same strength of oil emulsion alone. Fish-oil soap at various strengths was used to emulsify the linseed and cotton-seed oils. Where fish-oil soap was used at the rate of 1 gm.–50 cc. with a given strength of oil the greatest reduction usually occurred. More than likely one could kill 100 per cent of the eggs by using a strong fish-oil soap and at least 8 cc. to 92 cc. of linseed or cotton-seed oil and applying the same near the hatching period. The principal objection to such a combination would be its high cost.

Conclusions

The following statements concerning the structure, behavior and response of the eggs of *A. avenæ* and *A. pomi* (and probably *A. sorbi*) to environmental factors and various sprays are based on three years of study.

The eggs are covered with two distinct layers, an outer semi-transparent hardened shell and an inner pigmented (black) soft membrane. The outer shell is much more impervious to water than the inner black membrane (chorion). The outer shell splits (usually) along the dorso-mesal line a short time (in some cases over 30 days) before the inner pigmented membrane is severed by the nymph. Evaporating factors apparently influence the rapidity of the splitting of the outer layer. Low evaporation seems to delay the splitting, while high evaporation probably has the opposite effect. Evaporating factors also influence the percentage of hatch, particularly at the time when the eggs are splitting their outer shells. Incubator and other experiments where

moisture and temperature were controlled and also out-of-door observations during variable seasons show that high evaporating factors during the most susceptible period of the egg (10 to 15 days before hatching) decreases the percentage of hatched eggs while low evaporating factors during the same period increases the percentages of hatch.

The eggs are not only most susceptible to evaporating factors when many of the eggs are splitting their outer shells, but they are most easily killed by various contact sprays applied at this time. Experiments with a large number of contact sprays at their recommended winter strength shows conclusively that concentrated liquid lime-sulfur, 1–9 is the most efficient. The lower efficiency of recommended winter strengths of dry lime-sulfur and substitutes is probably in part due to the lower sulfur content of each. The insoluble character of dry lime-sulfur is also important in accounting for its inefficiency.

Nicotine added to any spray increases its efficiency in killing the eggs of *A. avenæ* and *A. pomi*. This was particularly true where nicotine, 1–500 is added to the recommended dormant strengths of concentrated liquid lime-sulfur, dry lime-sulfur and substitutes ("B. T. S." and "Soluble Sulphur").

Sodium sulfo-carbonate, 1–9 or 1–14 kills a large percentage of eggs and is worthy of further investigation. Various sprays made with hydrated lime, strong fish-oil soap solutions, miscible oil ("Scalecide," 1–15 to 1–40), crude carbolic acid, cresols, linseed and cotton-seed oil emulsions, etc., only kill a small percentage of eggs during December, January, February and the early part of March. Some of these sprays kill 80 to 95 per cent of the eggs if applied when the fruit buds first show green (March 21, 1919).

The New Jersey Agricultural Experiment Station is recommending a delayed dormant spray of concentrated liquid lime-sulfur, 1–9, combined with nicotine (Black Leaf 40), 1–500. This spray should be applied when the fruit bud is swollen and first shows green. Applications made after the leaves are out one half inch or more will burn the foliage of most varieties.

Key to Plotted Experiments on Charts Taken from Tables I and II. Similar Treatment Represented by Same Letter in all Charts. All 1918–1919 Experiments Except Chart I.

Expts. Plotted Table I (*A. avenæ*)	Expts. Plotted Table II (*A. pomi*)	Letters on Charts	Sprays
1*	1-p	a	Liquid lime-sulfur, 1–9
2	2-p	b	Liquid-sulfur, 1–6
3		c	Liquid lime-sulfur, 1–9 plus casein-lime, 1 gm.–100 cc.
4		d	Liquid lime-sulfur, 1–6 plus casein-lime, 1 gm.–100 cc.
6	4-p	e	Dry lime-sulfur (S-W), 15 lb.–50 gal.
7		f	Dry lime-sulfur (S-W), 20 lb.–50 gal.
8		g	Dry (dust form) lime-sulfur, (S-W), 15 lb.–50 gal.
10	6-p	h	"B. T. S.," 15 lb.–50 gal.
12	7-p	i	"Soluble-sulphur," 15 lb.–50 gal.
16*	9-p	j	Liquid lime-sulfur, 1–9 plus nicotine, 1–500
17	10-p	k	Liquid lime-sulfur, 1–6 plus nicotine, 1–500
18		l	Liquid lime-sulfur, 1–9 plus casein-lime, 1 gm.–100 cc. plus nicotine, 1–500
19		m	Liquid lime-sulfur, 1–6 plus casein-lime, 1 gm.–100 cc. plus nicotine, 1–500
21		n	Dry lime-sulfur (S-W), 15 lb.–50 gal. plus nicotine, 1–500
23		o	Dry (dust form) lime-sulfur (S-W), 15 lb.–50 gal. plus nicotine, 1–500
25		p	"B. T. S.," 15 lb.–50 gal. plus nicotine, 1–500
27		q	"Soluble sulphur," 15 lb.–50 gal. plus nicotine, 1–500
29		r	Hydrated lime, 1.75 gm.–50 cc.
32		s	Hydrated lime, 3.5 gm.–50 cc. plus casein-lime, 0.5 gm.–50 cc.
38*	21-p	t	"Scalecide," 1–15
33*		u	Fish-oil soap, 1 gm.–50 cc.
34*		v	Fish-oil soap, 1 gm.–50 cc. plus nicotine, 1–500
	18-p	w	Fish-oil soap, 1 gm.–100 cc. plus nicotine, 1–500
*		x	Fish-oil soap, 1 gm.–50 cc. plus crude carbolic acid, 1 cc.–99 cc.
36		y	Fish-oil soap, 1 gm.–50 cc. plus crude carbolic acid, 2 cc.–98 cc.
41		z	Linseed oil, 8 cc.–92 cc. plus laundry soap, 1 gm.–100 cc.
43		z-2	Cotton-seed oil, 8 cc.–92 cc. plus laundry soap, 1 gm.–100 cc.

* Similar experiments with eggs of *A. avenæ* for season of 1917–18. See chart I.

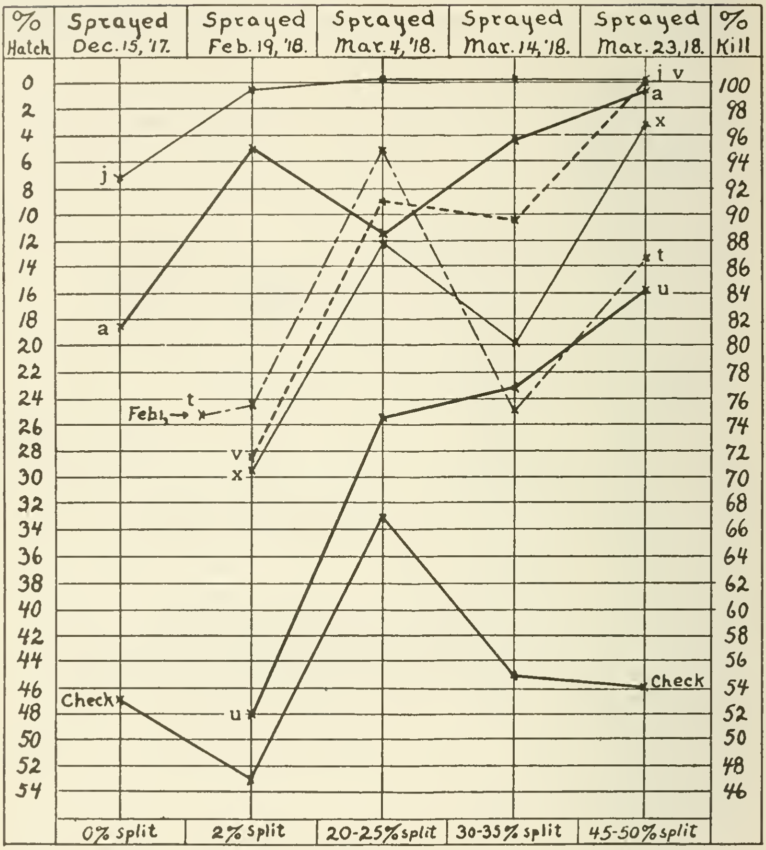


Chart I. Plotted lines showing the ovicidal value of several sprays on the eggs of *A. avenae* for the season of 1917–1918. These sprays are similar to some plotted on charts II, III, IV and V for 1918–1919.

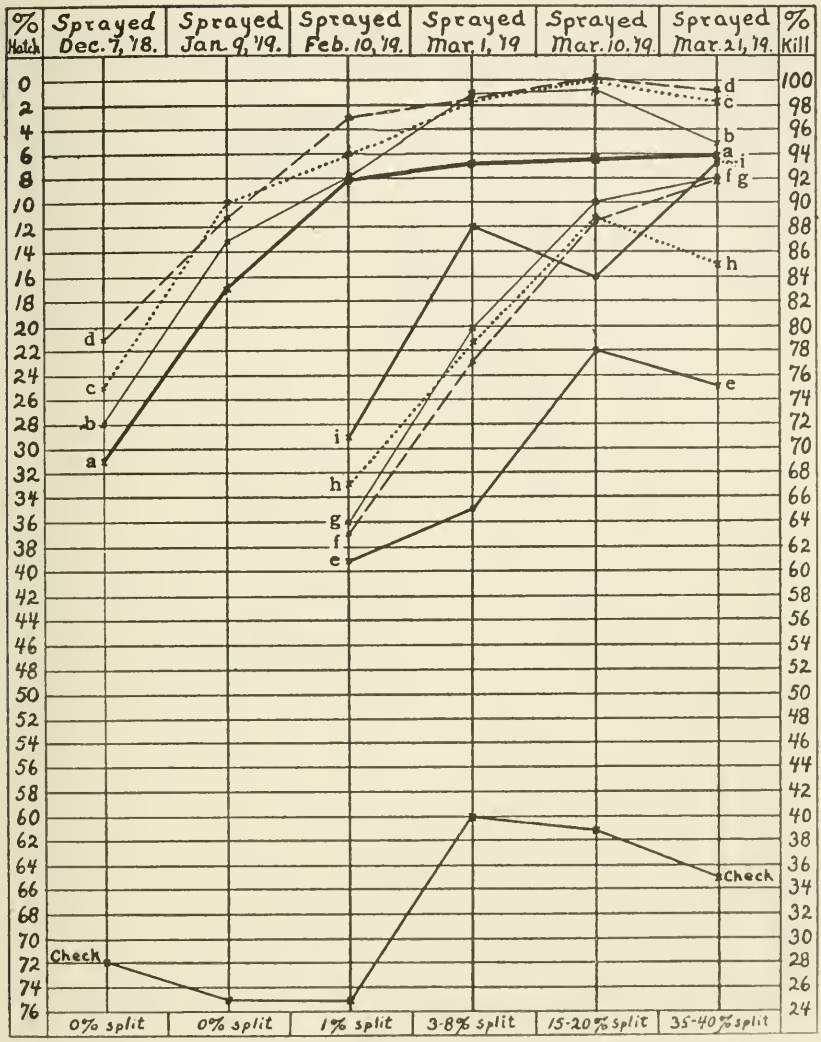


Chart II. Plotted lines showing superiority of concentrated liquid lime-sulfur, 1-9 and 1-6, over dry substitutes, 15 pounds to 50 gallons of water (dry lime sulfur (S-W), "B.T.S." and "Soluble sulfur") in killing the eggs of *A. avenae.* 1918–1919.

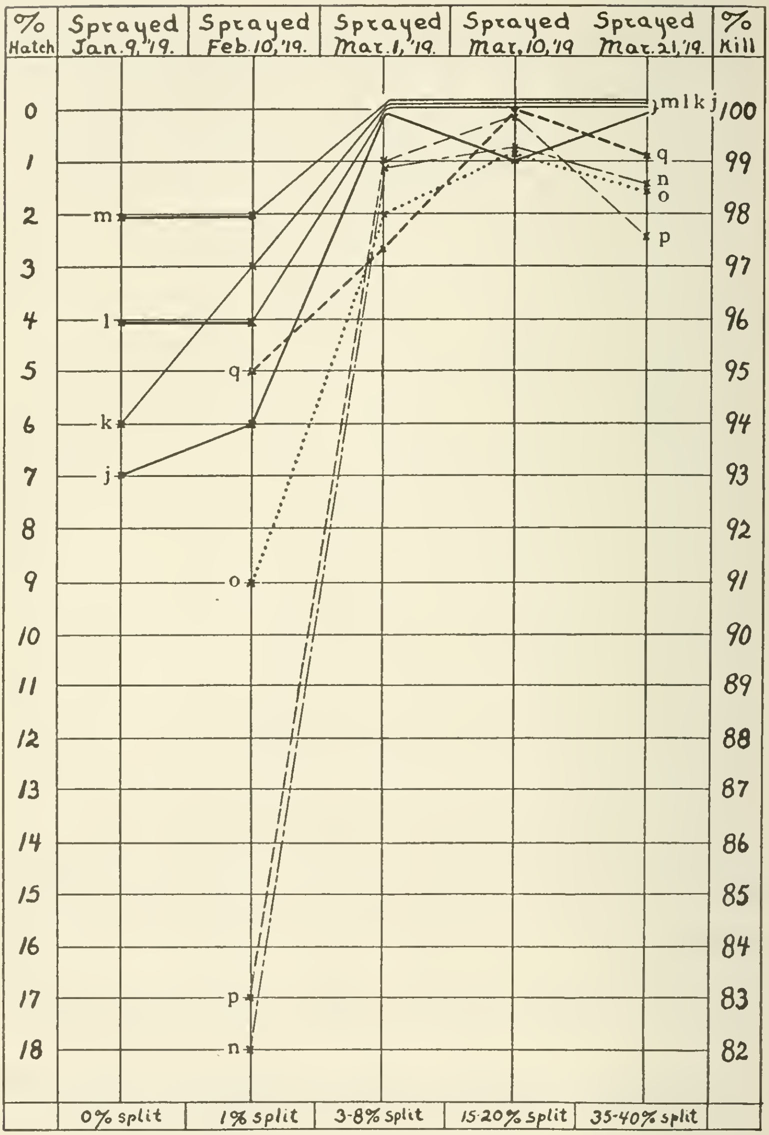


Chart III. Plotted lines showing results of experiments similar to those in chart II (same sprays and same strength) except for the addition of nicotine, 1-500 to each spray. Observe the decided increase in kill of the eggs of *A. avenae*, 97-100 per cent, when the various sprays were applied during March 1918-1919.

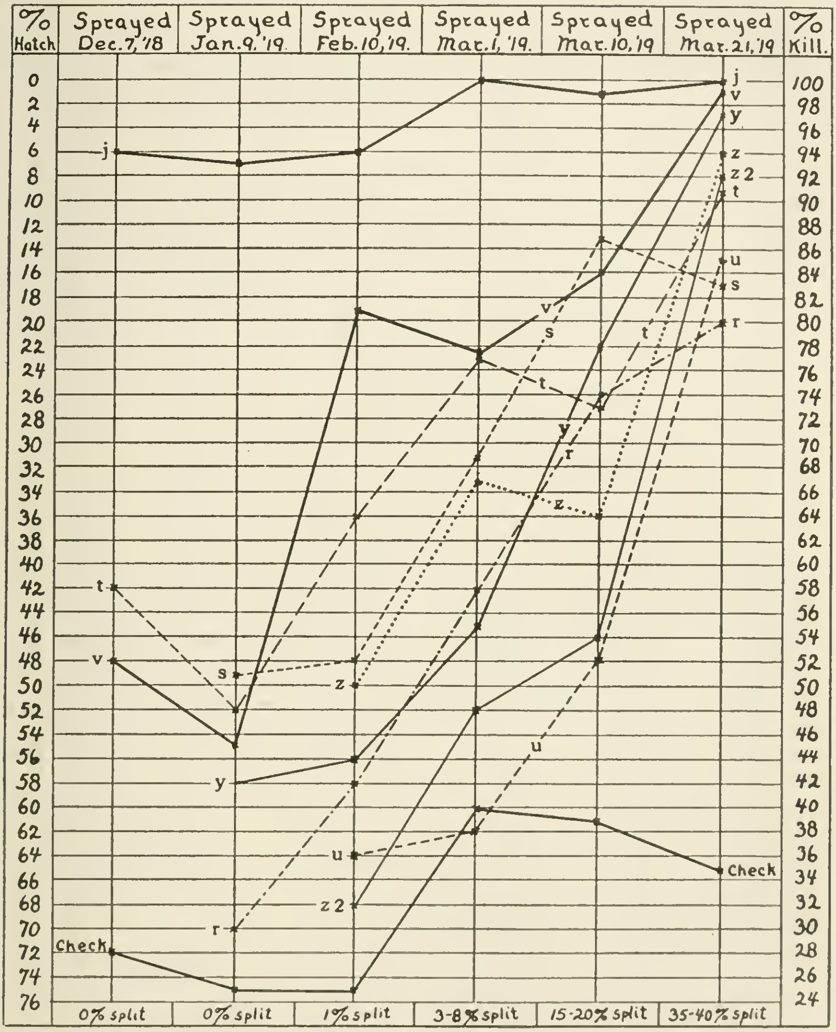


Chart IV. Plotted lines showing the superiority of recommended liquid lime-sulfur, 1-9 plus nicotine, 1-500 spray over other sprays ("Scalecide," hydrated lime, fish oil soap, fish oil soap combined with nicotine and with crude carbolic acid, linseed oil emulsion and cottonseed oil emulsion) in killing the eggs of *A. avenae*. Observe the decided increase in the killing effect of each spray when applied nearer the hatching period (or as the susceptibility of the eggs increases). 1918–1919.

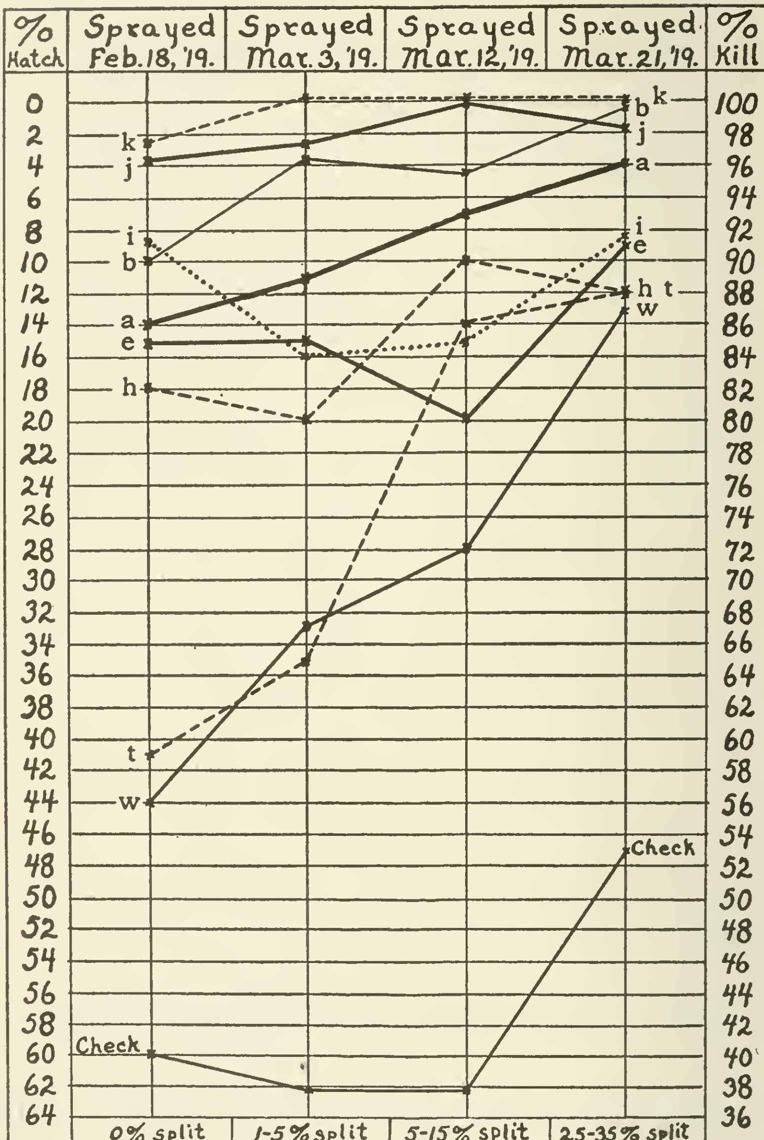
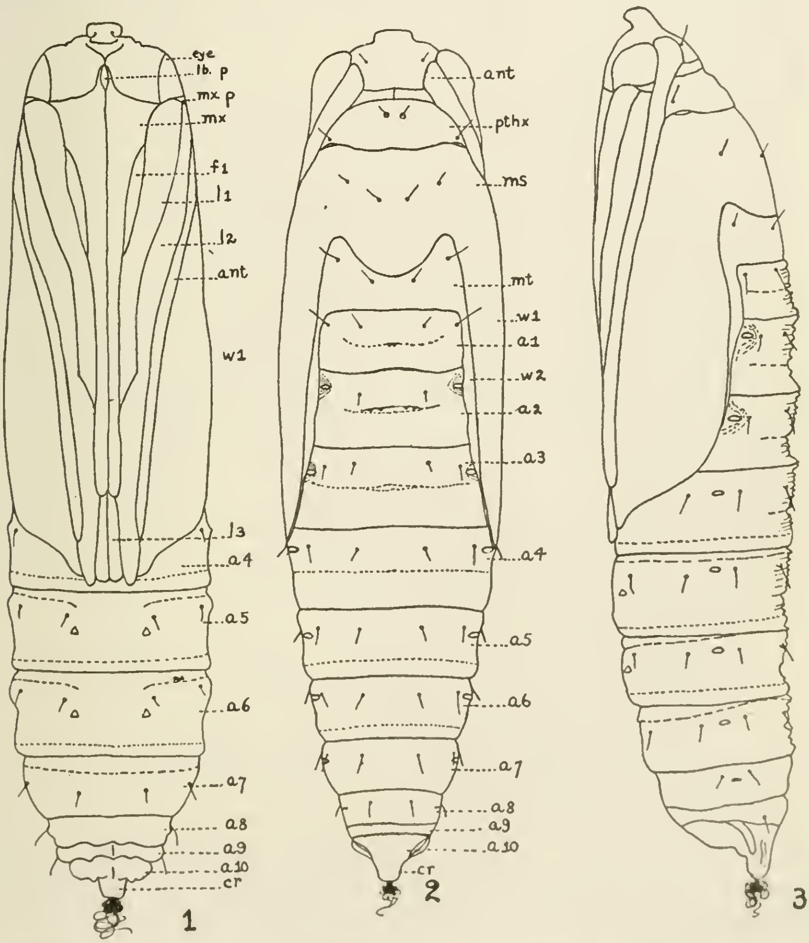


Chart V. Plotted lines showing the ovicidal value of several sprays on the eggs of *A. pomi*. 1918–1919.

NOTES ON THE PUPÆ OF THE EUROPEAN CORN BORER, PYRAUSTA NUBILALIS AND THE CLOSELY RELATED SPECIES P. PENITALIS

By Edna Mosher

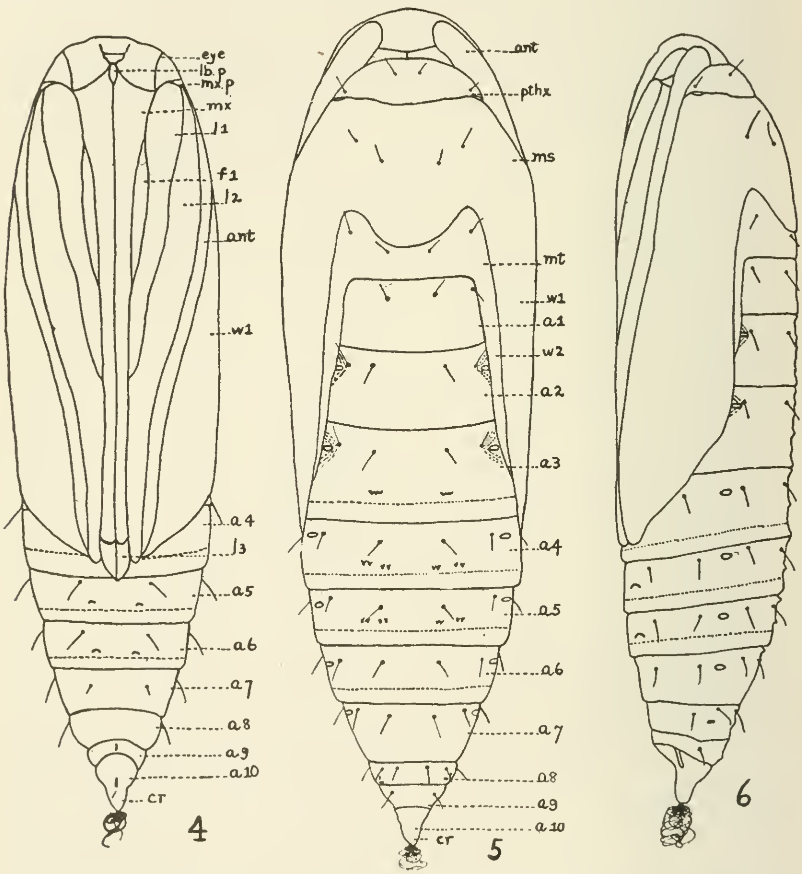
Since the larvæ of these two species of Pyrausta are so closely related, it is interesting to find that the pupæ are much more easily distinguished than the larvæ. The element of doubt which one may have



Pyrausta penitalis.—Fig. 18; 1 ventral view; *lb. p.*, labial palpi; *mx. p.*, maxillary palpi; *mx.*, maxillæ; *f* 1, femur of prothoracic leg; *l*1, *l*2, *l*3, legs; *ant.*, antennæ; *w*.1, *w*.2, wings; *pthx*, *ms*, *mt.*, thoracic segments; *a*1 to *a*10, abdominal segments; *cr.*, cremaster; 2, dorsal view; 3, lateral view.

in trying to identify the larva is entirely eliminated when these insects reach the pupal stage.

As in the larvæ, the pupæ of *P. nubilalis* are slightly longer and stouter than those of *P. penitalis*. The average length of the male pupa of *nubilalis*, when retracted is 13 mm., while that of *penitalis* is



Pyrausta nubilalis.—Fig. 19, 4, ventral view; 5, dorsal view; 6, lateral view. (Abbreviations as in *P. penitalis.*)

11 mm. The females average respectively 15 and 13 mm. Both species are yellow when young, tinged with brown on the head and cremaster. When older, especially in *nubilalis*, the dorsal surface becomes quite brown.

The main differences in the pupæ may be easily seen in the figures. Perhaps the most striking is the blunt projection on the head of *penitalis*. In the ventral views (Figs. 18, 19, 1 and 4) it will be noticed

that the maxillæ (mx.) and the antennæ (ant.) are considerably shorter in *penitalis*, and that the comparative length and breadth, as well as the shape of abdominal segments eight to ten varies considerably.

In the dorsal views (Figs. 18, 19, 2 and 5) it will be noticed that the head projects considerably cephalo-laterad of the antennæ in *penitalis*, while this projection is very slight in *nubilalis*. The dorsal surface of the abdomen is considerably wrinkled in *penitalis* and the first segments show rather deep furrows near the middle of the segment as indicated by dotted lines in the figure. On the first segment there are two small teeth on the cephalic side of the furrow, one on each side of the median line. On the second segment there are two or three teeth on each side, a little farther laterad than on the first. The furrow on the third segment is narrower and shows no teeth. The setæ on *penitalis* mostly arise from small projections, which are not quite so prominent in *nubilalis*. In *nubilalis* there are no dorsal furrows as described in *penitalis* and the surface is very little wrinkled, though somewhat roughened with minute projections. Near the caudal margin of abdominal segments four to six in *nubilalis* are some small triangular spines, never very distinct, which vary somewhat in number and arrangement. In some individuals there are traces of spines on segments three and seven. The lateral furrow of the tenth segment shows much more distinctly in a dorsal view of *penitalis*.

The lateral views (Figs. 18, 19, 3 and 6) merely emphasize some of the points previously mentioned and show the difference in the size of the lateral furrow of the tenth segment.

Mr. D. J. Caffrey of the European Corn Borer Laboratory in Arlington, Mass., furnished material for the study of *P. nubilalis*, while Mr. George G. Ainslie loaned material of *P. penitalis*, so that I am deeply indebted to both for making this study possible.

AN INJURIOUS LEAF-MINER OF THE HONEYSUCKLE

By C. R. Crosby and M. D. Leonard

In August, 1917, our attention was called by Charles Fowler to a serious outbreak of *Lithocolletes fragilella* Frey and Boll, on Belgica honeysuckle in a nursery at Honeoye Falls, N. Y. The plants growing in the open were badly infested by the miners, nearly every leaf showing one or more mines. In spite of this heavy infestation the injury to these plants was negligible. When, however, cuttings were taken from these plants and placed under glass in the cutting beds the leaves were so badly injured by the miners that the cuttings failed to grow. Several hundred cuttings placed in the beds June 26 were a total loss.

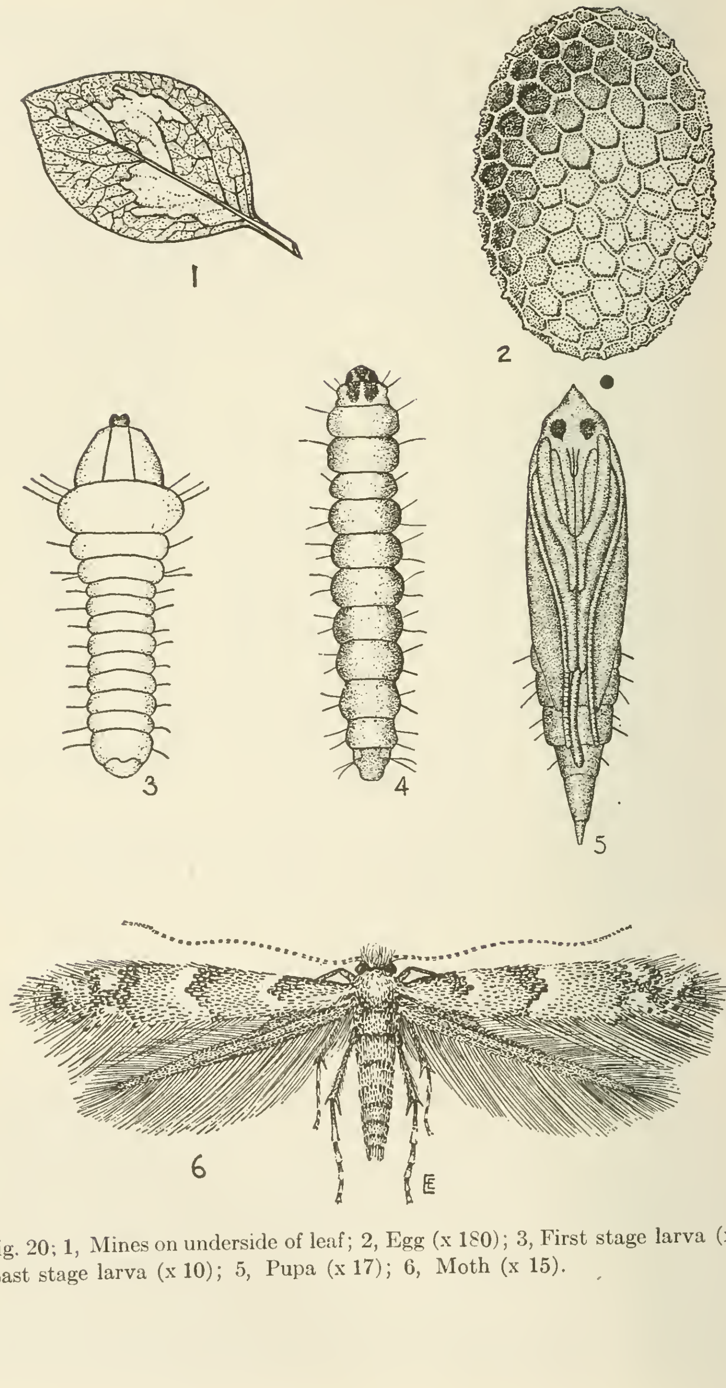


Fig. 20; 1, Mines on underside of leaf; 2, Egg (x 180); 3, First stage larva (x 210); 4, Last stage larva (x 10); 5, Pupa (x 17); 6, Moth (x 15).

A second lot planted July 26 fared the same. In a third lot, planted August 26, the injury soon became apparent. In making these cuttings the greenhouse foreman had been careful not to select cuttings on which mines were apparent but as many eggs were present on the leaves the injury soon appeared. Owing to the great difficulty of growing plants from green cuttings due to the depredations of this insect, this method of propagation has been abandoned at this nursery and hard-wood cuttings have been used instead.

We visited the nursery on August 26 and found moths, eggs, pupæ and all stages of the larvæ present on the plants out of doors. The eggs were deposited singly on the underside of the leaves. The egg (Fig. 20, 1) is oval in outline, flattened on the side of attachment, convex above and pale yellowish in color. The surface is beautifully sculptured with more or less regular hexagonal pits. The measurements of three eggs are as follows: .24 by .18; .26 by .16; and .28 by .2 mm.

The beginning of the mine is indicated by the empty egg shell. The young larva at first forms a linear mine on the underside of the leaf which gradually widens and extends along a vein. After running for about 5 mm. this abruptly enlarges into a blotch which obliterates the linear mine. The blotch mine (Fig. 20, 2) is on the underside of the leaf, is about 10 mm. in diameter and is usually outlined by the larger veins. There is only one larva in a mine but there are often several mines in a leaf.

The recently hatched larva (Fig. 20, 3) measures .44 mm. in length with the prothorax very wide. It is pale translucent or pale greenish from the ingested food with the head slightly brownish. In the next to the last stage the larva is about 2.5 mm. in length, pale yellowish in color, distinctly flattened and the prothorax is twice as wide as the head. The sides of the prothorax project so as to almost form tubercles. The body gradually tapers posteriorly and becomes nearly cylindrical. The head which is .25 mm. wide is slightly less rounded than in the next stage and is held in a nearly horizontal position. The legs are somewhat paler than in the full-grown larva.

The full-grown larva (Fig. 20, 4) is about 5 mm. in length, yellowish and nearly cylindrical with the last four or five segments tapering. The head is dark brown, almost black, with the cervical shield somewhat lighter. The thoracic legs are well developed and brown in color. Only three pairs of prolegs are present besides the usual anal pair, and are situated on the third, fourth and fifth abdominal segments. There is a small black bar between the prothoracic legs.

In the next to the last stage the larva lines the mine with silk and folds the leaf downward, puckering the under surface of the mine into

a series of parallel folds and at the same time somewhat crumpling the upper surface. About the same time it eats out holes in the upper parenchyma around the edges of the mine which show through as a series of pale spots. In the last stage the process is continued and the leaf is frequently folded double. Pupation takes place in a cocoon, elliptical in outline, about 6 mm. long by 4 mm. wide. The cocoon is composed of a single layer of silk and is attached closely to the upper lining of the mine and loosely to the lower.

The pupa (Fig. 20, 5) is 3.5 mm. in length, at first pale yellowish but becoming darker with age. The head ends in a pyramidal point directed downward, without visible serrations. The head, wing, leg and antennal cases are dark brown. The dorsal surface of abdominal segments 2 to 7 is armed on the front half with dark brown spinules and on the posterior quarter with a band of much smaller ones. The first and eighth segments show traces of a similar armature. Segments 4 to 7 are movable. When about to transform the pupa works its way partly out of the mine. In one instance we found a pupa skin projecting half its length through the upper surface of the leaf.

The moth (Fig. 20, 6) has an expanse of 6 to 7 mm. The fore wings are reddish brown with golden reflections in certain lights. Each is crossed by four narrow black bands bordered on the outside with white. The third and fourth bands are connected by a black bar. There is a black dot and a white crescent at the apex. The head is tufted with reddish brown hairs. The antennæ are long and slender and are banded with black and white. The hind wings, abdomen and legs are dark gray, with the tarsi black and white.

In 1873 Frey and Boll (Stett. Ent. Zeit. 34: 215) record rearing moths from mines in the leaves of *Lonicera sempervirens* from Cambridge, Mass., which they with doubt referred to *Lithocolletes trifasciella* Haworth. In 1878 (Ibid 39: 270) they described *L. fragilella* from specimens from Texas reared from mines on the underside of the leaves of *Lonicera albida*. In 1891 Lord Walsingham (Ins. Life 3: 326) stated that he had examined one of the specimens bred by Frey and Boll from *Lonicera sempervirens* from Cambridge and referred by them with doubt to *L. trifasciella* and pronounced it to belong to their *L. fragilella*. Cook (Third Rept. Mich. Agr. Exp. Sta. for 1890: 117) records rearing what appears to be this species from honeysuckle from Gratton, Mich., although he identified it as *L. trifasciella* Stainton and his description of the mine, larva and pupa does not agree with that of *L. fragilella*.

HIBERNATING HABITS OF TWO SPECIES OF LADYBIRDS

By David E. Fink, *Truck-crop Insect Investigations, U. S. Department of Agriculture*

Two species of ladybird beetles have similar hibernating habits in Tidewater, Va., the spotted ladybird (*Megilla maculata* DeG.), and the squash ladybird (*Epilachna borealis* Fab.), the former beneficial, the latter injurious. Both species were studied while the writer was stationed at Norfolk, Va., the former in connection with the ladybird colonization project for that region[1], the latter in its role as a pest on watermelon. It was observed that the beetles of *Megilla maculata* have a habit of congregating during late fall on the trunks of trees in the vicinity of its feeding areas, for concealment in deep crevices or under loose bark of trees as a protection during the winter months. Some speculation was indulged in to account for their repeated return to the same trees year after year, though it was certain, from the knowledge of their life-history, that the progeny of ladybirds that hibernated probably were not related any more closely than the fifth or sixth generation to their ancestors that had occupied the same trees previously.

Habits of Megilla maculata

During late fall, or after repeated heavy frosts, although aphides were still present on spinach, kale and cabbage, the ladybirds left these plants to find shelter elsewhere. In the localities where they had been artificially colonized, they were observed for several years seeking the protection afforded by certain trees growing in the immediate vicinity of farm buildings. They were attracted by different species of trees. In one locality they hibernated every year on pin oak (*Quercus palustris*), in another on hard maple (*Acer saccharum*), and in other places on red mulberry (*Morus rubra*) and red cedar (*Juniperus virginiana*).

When beginning hibernation the beetles do not alight directly on the tree trunks, but gather on the ground about the base of a tree, afterwards crawling up the trunk and seeking suitable cavities or loose bark for shelter. They arrive singly and by twos and a cavity soon harbors several hundred individuals, the size of the colony depending to some extent on the accommodation of the cavity or crevice. On large trees many natural shelters occur, and the ladybirds, discovering these, in due course divide into groups and occupy them. First the cavities on all parts of a tree are occupied, but with colder weather only the south and east exposures become inhabited. At no

[1] Bul. 15, Va. Truck Exp. Sta., Norfolk, Va., Apr. 1, 1915.

time during the winter are the ladybirds entirely dormant. The warm rays of the sun on mild days cause more or less activity among them, either in the form of an oscillating movement within the shelters or a migration along the trunk to other cavities.

Other forms of heat cause activity. An instance of this nature occurred in which a horse left tied close to a tree harboring this ladybird had his abdomen almost completely covered with the beetles in a short time. The heat of the animal had evidently awakened them to activity and, using the rein as a bridge, they had crawled beneath the horse's blanket, much to the animal's chagrin, and he was unable to get rid of them by switching his tail.

Early in spring the beetles leave the trees and scatter in the surrounding fields.

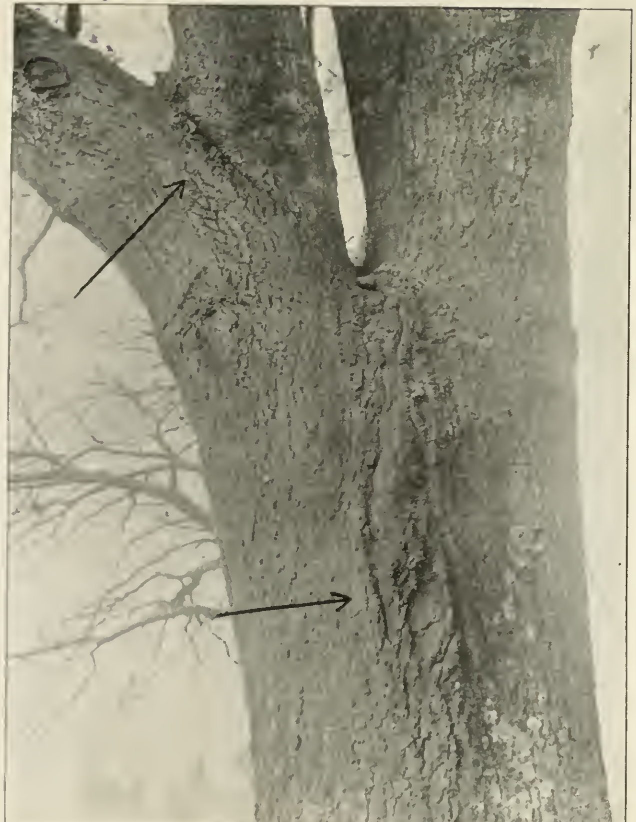
To account for their repeated return to the same trees for successive years several theories were considered. One theory was that as ladybirds are known to emit a strong odor, the trees become impregnated to such a degree as to serve as an attraction to future generations. Although no such odor could be detected at any time it was thought possible that our limited olfactory senses failed to detect what was perhaps quite keen to the insects. Nevertheless the cavities remain unoccupied for at least eight months of the year, during which time the tree is constantly exposed to the elements; besides, the odor must be penetrating to attract the insects from a considerable distance.

Afterwards, the natural odor from the tree was considered as a possible attraction, yet the variety of trees which they frequent together with the fact that they also hibernate between boards along fences and among piled stakes, precludes the serious consideration of this theory. Experiments were made by confining slabs of bark of oak, maple, cedar and mulberry in cheesecloth cages and liberating ladybirds in them to determine whether or not the odor of the bark would attract them. In every instance the beetles entirely ignored the bark, preferring to hide in the crevices made by the cloth and supporting posts.

The possibility of an inherited instinct of attraction to trees was also considered as a plausible factor. The fact that the beetles return to the same trees year after year, however, and the further fact that some individuals hibernate on material other than trees, necessitates the abandonment of this theory also.

Finally, the conclusion was reached that frequent hibernation on the same trees is purely accidental, or merely a matter of convenience, being confined to those beetles in the immediate vicinity and to accidental individuals from among those hibernating on other material.

The process by which the species manages to assemble on the same



Megilla maculata hibernating on pin oak (*Quercus palustris*). The arrows point to two colonies.

Megilla maculata hibernating on pin oak (*Quercus palustris*). A reduced view of one colony.

trees every year is as follows: *Megilla maculata* feeds almost entirely on aphides which occur on various crops in near-by fields. As cold weather approaches the aphides breed in larger numbers on crops that are more or less protected, as in fields nearest buildings or trees. Such places are also more favorable to a longer activity of the beetles. The tendency, therefore, is for the ladybirds gradually to drift from outlying portions of a field to places near the protected parts where food is more abundant. In any given locality the conditions are the same year after year, so that at the end of the growing season the majority of the beetles are in the neighborhood of trees that are excellently adapted for the purpose of tiding them over the winter months, irrespective of the fact that these same trees were used the previous year for the same purpose by the ladybirds' predecessors.

Habits of Epilachna borealis

The squash ladybird possesses the same habit of seeking trees for protection during the winter, although it undoubtedly hibernates in other places. Beetles of this species, however, do not always return to the same trees, as is the case with *Megilla maculata*, because their main food plants are often shifted from one locality to another. Rotation is a very common and successful practice in watermelon culture, the same field not being used a second time for this crop until the lapse of four or more years. In other respects the hibernation habits of these two species are identical; indeed, in the watermelon regions of Virginia the two species are commonly found hibernating together.

The fact that they do not inhabit the same trees every season was determined as follows: In one locality they hibernated on hickory (*Hicoria glabra*). The following year they were observed on two large persimmons (*Diospyros virginiana*) growing in the center of a watermelon field, and other individuals were found on pines bordering the same field, but none of the ladybirds occurred on the hickory tree that they used the previous season, although the fields were only 500 feet apart. In another locality the ladybirds were observed one season hibernating in old apple trees on the border of a watermelon field. The following year they hibernated on a row of red cedar (*Juniperus virginiana*), and none were found on the apple trees.

The habit of this species of seeking winter quarters according to convenience seems to confirm the conclusion drawn with respect to the accidental return of *Megilla maculata* to the same trees. Both species are guided in their choices by their feeding habits. With the former the conditions are more or less fixed, while with the latter crop rotation involving the insect's food plant causes the beetles to migrate from field to field.

XANTHONIA VILLOSULA MELSH. INJURING FOREST TREES

(Coleoptera, Chrysomelidæ)

By Walter H. Wellhouse, *Cornell University, Ithaca, N. Y.*

During the summer of 1918 a number of different forest trees about Ithaca were injured by small brown leaf beetles. They were determined as *Xanthonia villosula* Melsh. by Mr. Charles W. Leng. The writer first noticed them feeding on the leaves of Cratægus on June 27, the leaves on a few small trees being almost completely riddled by them. A few days later they were seen feeding on other trees in a woodlot near Cornell University and soon they were found to be quite generally distributed in wooded areas about Ithaca. Small trees with foliage near the ground were often found to be nearly defoliated and occasionally a large tree had most of its leaves perforated with their feeding holes.

This insect was described by Dr. F. E. Melsheimer in 1847. It was reported by Mr. J. Stauffer of Lancaster, Pa., as "committing heavy depredations" on grape-vines in July, 1865. The injury was probably only local since there seems to be no other account of it. The beetles have been taken by collectors and recorded in systematic papers quite often, but its life-history and habits seem to be unknown. Dr. J. B. Smith stated that it is common in New Jersey on oak and hazel. Mr. Chittenden found it on leaves of hickory. Mr. W. S. Blatchley says it was beaten from hazel and oak in Indiana.

The hornbeam (*Carpinus caroliniana* Walt.) and the ironwood trees (*Ostrya virginiana* Willd.) seemed to be most frequently attacked last summer, but the writer found it also feeding on the leaves of *Cratægus punctata*, shag-bark hickory (*Carya ovata*), hard maple (*Acer saccharum*), linden (*Tilia americana*), white oak (*Quercus alba*), wild grape (*Vitis riparia*), wild blackberry (*Rubus* sp.), witch hazel (*Hamamelis virginiana*), wild rose, *Waldstenia fragarioides*, and wild strawberry (*Fragaria virginiana*).

The adults were found feeding on the leaves from June 27 until August 2 at Ithaca. Their feeding habit is quite characteristic. They cut a chain of small holes close together on the leaf, leaving only a thin cross bar of leaf tissue between the holes. The hole which forms each link in the chain is seldom more than one millimeter in diameter. The beetles drop quickly to the ground when disturbed and are readily beaten down into a net. They vary in color from brown to black, some being entirely brown, some black and a few are part brown and part black. The writer has found brown ones and black ones mating

together and two of the same color mating. These two color forms have been known as separate varieties, *stevensi* Baly and *plagiatus* Melsh. They mated and deposited eggs during the last half of July.

The eggs were laid in moist earth just below the surface of the ground. One mass was found to contain nineteen eggs glued together with a viscous covering. The egg is elliptical in form, is 0.65 mm. long and 0.3 mm. broad at the middle. It is smooth and a glistening white in color.

The larvæ have not yet been found but probably live in the ground and feed upon the roots of plants.

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NAPHTHALENE VS. CHICKEN LICE[1]

By W. S. ABBOTT, *Bureau of Entomology*

In connection with the work of testing proprietary insecticides and their ingredients, which is carried on at the Insecticide Board's Testing Laboratory located at Vienna, Va., a considerable amount of data has been obtained on the value of naphthalene as a chicken lice remedy. These experiments have been summarized, and since much of this data is new they are presented here in the hope that they may be of value to economic entomologists who are interested in this line of work.

Naphthalene is a very common ingredient in proprietary lice powders, occurring in those tested in quantities ranging from .17 per cent to 67 per cent. It is also found on the market moulded into the form of nest eggs which may be pure naphthalene or naphthalene mixed with paraffin, clay, plaster, etc.

The hens used in these tests were of no particular breed or age, and were all moderately to badly infested with chicken lice of several species. The common body louse, *Menopon biseriatum* Paiget, was the most abundant, but *M. pallidum* Nit., *Lipeurus heterographus* Nit., and *Goniocotes abdominalis* Paig., were often present.

[1]Published with the consent of the Secretary of the U. S. Department of Agriculture.

Naphthalene was tested in three ways:

1. As a dust in various percentages.
2. Sprinkled over the backs of the fowls while they were on the roost at night.
3. In the form of nest eggs.

Naphthalene as a Dust

In these experiments the chickens were held by one person and dusted by another. The powders were applied by means of a hand dust gun or shaker and, unless otherwise noted, were well rubbed into the feathers. The fowls were confined in cages or small chicken houses and were carefully examined one or two days after treatment when the percentage of lice killed or repelled was estimated. Various finely powdered materials, such as lime, charcoal or flour were used on carriers, it having been proved that these materials were not effective against lice.

Table No. 1 gives the results of these dusting tests.

Table I. The Results of Tests with Naphthalene Used as a Dust Against Chicken Lice

Test No.	Per Cent Naphthalene	Inert Carrier	Number of Hens Dusted	Duration of Test	Per Cent of Lice Killed or Repelled	Remarks
1	1.5	Lime	2	2 days	5–10	
2	5.0	Flour	3	1 day	10	
3	10.0	"	6	"	90–95	All sick but soon recovered
4	15.0	"	5	"	95–98	do
5	20.0	"	4	"	95–100	do
6	60.0	Charcoal	4	"	100	Not rubbed in; hens sick but recovered
7	"	"	4	"	100	Rubbed in; hens killed
8	100.0	None	1	15 hours	100	do
9	"	"	1	1 day	100	Not rubbed in; hens sick but recovered

These data show that a powder containing 5 per cent or less of naphthalene is of no value against chicken lice, while 10 per cent or more is very effective.

In all cases where 10 per cent or more of naphthalene was used and well rubbed into the feathers, the fowls were slightly injured. The lower percentages seemed to partially stupefy the fowls and to temporarily deprive them of the free use of their legs. They would slump down on the ground with their eyes closed and frequently fall over on one side. When aroused they would run about and then settle down as before. These symptoms would last for five or ten minutes and then recovery seemed to be complete, as no ill effects were noticed after this. It is apparent, however, that until the exact character and the amount of this injury has been accurately determined, powders

containing more than 10 per cent of naphthalene should be applied with considerable caution.

Birds that were dusted with 60 per cent or 100 per cent naphthalene were killed when the powder was thoroughly rubbed into the feathers, but were not permanently injured when lightly dusted.

Naphthalene Sprinkled over the Fowls While at Roost

Since a method of controlling chicken lice which did not necessitate catching and treating each bird individually would be of great value to the poultryman, a series of tests was made to determine the effects of treating the fowls while they were on the roost. In these tests finely powdered naphthalene was sifted or sprinkled over the backs of lousy hens after they had settled down on the roost at night,care being taken to disturb them as little as possible. Tests 1 to 3 were made in cages in the greenhouse and Tests 4 to 9 in small hen houses.

Table II gives the results of these tests.

Table II. The Results of Sprinkling Naphthalene over the Backs of Lousy Hens While They were on the Roost at Night

Test No.	Number of Hens Dusted	Per Cent of Naphthalene	Per Cent of Lice Killed or Repelled	Temperature		Remarks
				Max.	Min.	
1	2	60	95	..	..	
2	2	60	98–99	..	..	
3	2	100	98–100	..	..	
4	5	"	80	80°	66°	
5	5	"	0–80[1]	70°	64°	Hens very restless
6	5	"	0–98[2]	64°	51°	One hen shook the powder off
7[3]	5	"	98–100	71°	41°	
8[3]	4	"	95	"	"	
9[3]	5	"	80	"	"	

[1] Two hens about as badly infested as before treatment.
[2] One hen about as badly infested as before treatment.
[3] Dusted on two successive nights.

These data show that 32 out of 35 hens used were greatly benefited by the treatment, it being estimated that from 80 to 100 per cent of the lice had been killed or repelled. In Test 6 the one bird not benefited was known to have fluttered and shaken herself just after the naphthalene was applied. In Test 3 it was noted that the hens were very uneasy and it seems probable that the two which remained infested with lice also shook off the powder before settling down on the roost.

Although the lice were not completely eradicated a very material reduction in the number present was observed on over 90 per cent of the fowls and the results are about as good as would be obtained by dusting as it is ordinarily done.

It is not claimed that this method of treatment has been given an

exhaustive trial or that it should be generally adopted, but the results indicate that it may furnish a very rapid and convenient means of reducing the numbers of lice to a point where they will no longer be a serious problem.

It is hoped that some reader may be in a position to give this method a thorough test on a commercial scale.

Naphthalene Nest Eggs

The following tests were made to determine the value of naphthalene nest eggs which have been recommended as efficient agents for the control of lice on laying and setting hens.

Laying Hens. In these tests the eggs were placed in the nest used by laying hens which were known to be very lousy, and the hens were examined every week until they ceased to lay.

Table III gives the results of these tests.

Table III. The Results of Tests with Naphthalene Nest Eggs Against Lice on Laying Hens

Test No.	Per Cent of Naphthalene	Number of Hens Used	Duration of Test	Per Cent of Lice Killed or Repelled
1	100	2	8 days	0
2	100	3	17 "	0
3	100	2	24 "	0
4	100	4	25 "	0

This table shows that naphthalene nest eggs are of no value against lice on laying hens.

Since the length of time that a laying hen would remain on the nest and exposed to the action of the nest egg would vary with the individual hen and with the number of eggs laid during the test, further experiments were made to determine the effect of what was considered to be a maximum exposure. A box just large enough to hold a hen but in which it could not stand up, was made. The bottom of this box was covered with excelsior on which a naphthalene nest egg was placed. Two one-inch holes were bored in one end of the box to furnish ventilation. A hen, badly infested with lice, was placed in this box and the lid was closed so that the bird was forced to remain on the egg for about thirty minutes on the following dates: September 6, 7, 8, 10, 11 and 14. At the close of this experiment the hen was found to be as badly infested with lice as before treatment. This experiment was duplicated, using nest eggs containing 46.4 per cent and 6.9 per cent of naphthalene and the same results were obtained.

Setting Hens. In the tests against lice on setting hens the nest egg was placed with the setting of eggs and allowed to remain there during the entire experiment.

Table IV gives the results of tests with these nest eggs against lice on setting hens.

TABLE IV. THE RESULTS OF TESTS WITH NAPHTHALENE NEST EGGS AGAINST CHICKEN LICE INFESTING SETTING HENS

Test No.	Duration of Test	Results	Number of Chickens Hatched	Remarks
1	7 days	Not noted	0	Hen left nest
2	21 "	Still infested	0	Hen did not remain constantly on nest
3	14 "	Not noted	0	Hen left nest
4	11 "	Still infested	0	do
5	20 "	do	0	Hen did not remain constantly on nest
6	22 "	Not noted	6	4 hens used; three left the nest
7	9 "	Still infested	0	Hen left the nest
8	23 "	do	6[1]	Many mites in nest
9	23 "	Not noted	6[2]	6 hens used; 5 left the nest

[1] Three chickens died. [2] Four chickens died.

This table shows that, in every case where records could be taken, the naphthalene nest egg did not reduce the number of lice, although in Tests 2, 5 and 8 the hens remained more or less constantly on the eggs for about three weeks. These results were confirmed by examinations made at irregular intervals on the hens that left the nests.

It will be noted that in six of the nine tests the hens left the nests and in two other tests the hens did not set well, leaving only one hen that completed the full incubation period in a normal manner, and from this setting of sixteen eggs only three chickens survived. Tests 6 and 9 are of particular interest, since they show the effects of naphthalene nest eggs on setting hens under conditions of extremely hot weather. These tests were made in a barn where the temperature ran very high and the hens were all very seriously affected by the naphthalene eggs. After setting for a period ranging from one to four days, eight of the hens used left the nest, showing very pronounced signs of injury which in some instances lasted for several days. The symptoms were very similar to those produced by dusting with naphthalene, but were much more pronounced and recovery was much slower. The exact cause of this injury is not known, but it may be that the naphthalene is toxic when absorbed through the skin. That the naphthalene is taken into the body was determined by one experiment where a hen, that had been setting for some time on a nest egg containing only 6.49 per cent of naphthalene, was killed by the writer, and when cooked twenty-four hours later was found to taste so strongly of naphthalene that it could not be eaten.

The fact that only 18 chicks hatched from 75 eggs and that 7 of them died within 2 or 3 days would indicate a very pronounced injury from the naphthalene nest eggs, but since in almost every case the

hens did not "set well," it is impossible to determine the exact cause of this high mortality.

The failure of these eggs to control lice is probably due to the fact that naphthalene vapor is over four times heavier than air and, therefore, does not work up through the feathers, although, as previously mentioned, a certain amount is taken into the hen's body, probably from direct contact with the egg.

It might be added that in many of the tests the nests and even the naphthalene eggs themselves were found to be swarming with chicken mites (*D. gallinæ* Redi.).

Summary

1. Powders containing 5 per cent or less of naphthalene are of no value against lice.
2. Powders containing from 10 per cent to 20 per cent are very effective.
3. As little as 10 per cent naphthalene may temporarily injure hens, if the powder is well rubbed in, and 60 per cent or more may kill the treated fowls under the same conditions.
4. Naphthalene (60 to 100 per cent) sprinkled over the backs of fowls at roost proved to be of considerable value against lice.
5. Naphthalene nest eggs are of no value against lice on laying or setting hens.
6. The data obtained indicate that setting hens, the eggs and possibly any chickens hatched are injured by these eggs.

THE DEPLUMING MITE OF CHICKENS: ITS COMPLETE ERADICATION FROM A FLOCK BY ONE TREATMENT

By H. P. Wood, *U. S. Bureau of Entomology*

During the course of experiments with the control of poultry lice a few flocks infested with the depluming mite[1] were encountered.[2] Inasmuch as treatments heretofore have consisted merely of ointments applied to the parts visibly affected, it was deemed worth while to attempt to find a method of completely destroying the mites in an infested flock. After a few preliminary experiments we were fortunate in discovering a method which has obtained the desired results.

The depluming mite is found in a scale surrounding the base of the feathers. To discover the mite on infested fowls it is only necessary

[1] Known scientifically as *Cnemidocoptes gallinæ* Railliet.

[2] This investigation was carried out at the Dallas, Texas, laboratory of the Bureau of Entomology, under the direction of Mr. F. C. Bishop.

to pluck a few feathers from several regions of the fowl and examine with a lens the scales around the base of the quill. The head of the mite may be seen projecting slightly through the scale which is removed with the feather. This scale is larger than on a normal feather. It is often more difficult to find them on broken feathers than on whole feathers for the live mites are more often found on the whole feathers. Though in bad infestations either live or dead ones may be found on any feathers. As many as three adults have been found in one scale.

The adult female gives birth to larvæ still encased in the egg sack, the larva extricating itself from the egg sack soon after birth. Mites were found on feathers taken from back, top of wing, near vent, breast and thighs but none from tail or primary or secondary wing feathers. In the tunnel with a female were found thirty-one larvæ.

The damage to the plumage is very evident. Infested fowls have a ragged appearance with a good many broken feathers or perhaps bare spots. This appearance is more evident in the summer and fall than it is soon after molting. It is quite evident that any damage done to plumage would be detrimental to show birds. We believe also that more injury is done to poultry generally by this mite than is commonly supposed. There seems to be some itching which may result in feather pulling, causing some hens to become quite bare. The time fowls spend in combating this pest would better be spent in resting or getting food, thus producing increased growth or larger egg yield.

This mite seems to be quite generally distributed, according to reports of various authors. We have collections from Texas, and Mr. O. G. Babcock has sent us collections from Tennessee, Missouri and Mississippi. Even in infested districts, however, many flocks appear to be entirely free from the mites.

The following substances were tried out in preliminary control experiments: Lime-sulphur, potassium sulphuret, tobacco-sulphur, dry sulphur, arsenical dip (B. A. I. formula, white arsenic 8 lbs., sal soda 24 lbs., pine tar 1 gal., and water to make 500 gallons), kerosene emulsion, sulphur and sodium fluoride, sodium fluoride, soap and water, sulphur, soap and sodium fluoride. Sodium fluoride was included in the last two formulæ to see if both lice and the depluming mite could be killed in one treatment.

Lime-sulphur: One lb. lime, 2 lbs. sulphur, 1 gal. water. Dilution, 1 to 20 parts water. Fourteen days after treatment no live mites could be found; all lice were not killed.

Potassium sulphuret: One-half oz. soap, ½ oz. potassium sulphuret, 1 gal. water. Sixteen days after treatment some mites found alive.

Tobacco-sulphur: Three teaspoonfulls "Black Leaf 40," 6 ozs. sulphur, 2½ gal. water. Eleven days after treatment no live mites or lice found.

Dry sulphur: Thoroughly dusted with flowers of sulphur. Twelve days after treatment no live mites found.

Arsenical Dip (B. A. I. formula): Made about three months, exact strength at time used not known. Fifteen days after treatment no live mites found.

Kerosene emulsion: Two gals. kerosene, ½ lbs. soap, 1 gal. water. Dilution, 1 to 10. Thirty-nine days after treatment no live mites found but fowl's skin was injured by burning.

Sulphur and sodium fluoride: Two-thirds oz. NaF., 2 ozs. sulphur, 1 gal. water. Five days after treatment one live mite found. A later observation should have been made.

Sodium fluoride, soap and water: Three-fourths oz. NaF., ½ oz. whale oil soap, 1 gal. water. Sixteen days after treatment live mites found.

Sodium fluoride, sulphur, soap and water: Two-thirds oz. NaF., 2 ozs. sulphur, soap (enough to make the water soapy), 1 gal. water. Sixteen days after treatment no live mites found.

In these experiments one hen was used in each experiment. The birds were held under the solution about one minute, during which time the feathers were thoroughly ruffled and the heads ducked two or three times.

Summary of Preliminary Experiments in Depluming Mite Control

Substance Used	All Mites Killed	Injurious Effect
Lime-sulphur	Yes	None
Potassium sulphuret	No	None
Tobacco-sulphur	Yes	None
Dry sulphur	Yes	Negligible
Arsenical dip	Yes	None
Kerosene emulsion	Yes	Injurious
Sulphur and sodium fluoride	No	None
Sodium fluoride, sulphur and soap	Yes	None

Of these substances, lime-sulphur, tobacco-sulphur, dry sulphur, B. A. I. Dip, and sodium fluoride, sulphur and soap were effective. Inasmuch as we have found sodium fluoride so effective against lice we thought it advisable to try on a larger scale to see if both the lice and depluming mite could be eradicated at one treatment.

June 30, 1917, 48 fowls infested with lice and the depluming mite were dipped in a solution of sodium fluoride (chemically pure) ⅔ oz., sulphur 2 oz., soap (laundry) ⅓ oz. (about), water 1 gal. A number of feathers were plucked from the treated fowls 27 days, 55 days, and about 5 months, 6½ months, 11 months, 1⅓ years after treatment and at no time were living mites or lice found.

A warm day was selected to treat the fowls and there was no injury to them. The experiment may, therefore, be considered, a complete success. A subsequent experiment on 120 hens infested with depluming mites, treated June 5, 1918, in the same way as in the above experiment and observed until January 17, 1919, verified the results of the previous experiment.

EUROPEAN CORN BORER CONFERENCE

A conference of about fifty Commissioners of Agriculture, official entomologists, inspectors, etc., representing twenty-two states, in addition to officials from the U. S. Department of Agriculture, and from the Dominion of Canada, was held at Albany, N. Y., August 28, and at Boston, Mass., August 29.

At Albany, the opening meeting was held in the forenoon in the State Education Building, after which a luncheon was given by the New York State Museum. In the afternoon all visited the infested corn fields in the vicinity of Schenectady, being transported in motor cars. A meeting of Commissioners of Agriculture was scheduled for the evening, and the entomologists gathered for an informal meeting where was freely discussed the general policy of suppressing the corn borer.

Reservations had been made on the night train for Boston, and at the morning meeting at the State House, a brief summary of the situation in Massachusetts was given by Mr. Wilfred Wheeler, commissioner of agriculture. The corn borer laboratory in Arlington was then visited where Mr. D. J. Caffrey gave an interesting account of the life history of the European corn borer as revealed in two years' work with this insect in Massachusetts. After a luncheon furnished by the Arlington Board of Trade, an inspection was made of some infested fields, and demonstrations were given of methods of burning weeds and of crushing stalks to kill the larvæ in them. A visit was also made to the gipsy moth laboratory, Melrose Highlands, and on the way one of the automobile truck power sprayers was seen in action.

Finally the committee on resolutions, appointed at the first session in Albany, submitted the following report which was adopted by the conference:

BOSTON, August 29, 1919.

Whereas, the European corn borer has become well established in both Massachusetts and New York state, and during the past two years, has seriously damaged both sweet and field corn in Eastern Massachusetts, and

Whereas, it has spread rapidly this season and will, unless speedily checked in both states, spread quickly over large areas heretofore uninfested and in a few years may cause enormous losses which might run into many millions of dollars.

Therefore, we, the National Association of Commissioners of Agriculture, with official entomologists from many states and representatives of the U. S. Department of Agriculture, together with representatives of the Canadian Government, present as experts in conference upon the situation, express ourselves, after examining the infested area, as thoroughly convinced that this pest is one of the most dangerous insects which has become established in America, and we hereby place ourselves on record in favor of most energetic efforts on the part of federal and state agencies to control, and, if possible, exterminate this insect, including in the program vigorous quarantines to prevent its distribution.

The danger of spread is so great, the probabilities of successful control under American conditions so unpromising, that we unhesitatingly recommend most energetic measures to control this very serious enemy of our principal grain crop. The immensity of the interests threatened leads us to advise a comprehensive plan of action which may involve the expenditure by the general government of much larger sums than are recommended in these resolutions.

We urge the present Congress to appropriate and make available for use as rapidly as an effective organization to carry on the work can be secured and developed, in addition to funds already available, two million dollars, the sum to be requested for the calendar year of 1920, to be determined by the future developments of the work.

We would at this time call attention to the necessity of all commissioners of agriculture and entomologists throughout the United States of America and Canada, taking an active interest in this insect, and we would hereby urge the dissemination of information respecting the situation by the appropriate agencies in each state and by the Federal Government.

We would recommend for the purpose of promoting the control and extermination of this borer the appointment of a committee representing the commissioners of agriculture, official entomologists and the Plant Pest Committee for the purpose of unifying and directing all efforts for the securing of appropriations and to aid in the determination of a comprehensive policy.

C. P. Norgord, *Commissioner of Agriculture*, Wisconsin.
Charles McCaffree, *Industrial Commissioner*, S. Dakota.
Wilfrid Wheeler, *Commissioner of Agriculture*, Massachusetts.
E. P. Felt, *State Entomologist*, New York.
George A. Dean, *Professor of Entomology*, Experiment Station, Kansas.
R. W. Harned, *State Entomologist*, Mississippi.
Committee on Resolutions.

Among those in attendance, the following entomologists were noticed: E. D. Ball, Iowa; A. F. Conradi, South Carolina; E. N. Cory, T. B. Symons, Maryland; E. C. Cotton, Ohio; G. A. Dean, Kansas; E. P. Felt, P. J. Parrott, G. W. Herrick, J. G. Needham, C. R. Crosby, M. D. Leonard, D. B. Young, E. A. Rundlett, New York; H. T. Fernald, W. M. Wheeler, C. T. Brues, Massachusetts; W. P. Flint, Illinois; Philip Garman, W. E. Britton, Connecticut; R. W. Harned, Mississippi; T. J. Headlee, John J. Davis, New Jersey; H. E. Hodgkiss, Pennsylvania; Wilmon Newell, Florida; W. C. O'Kane, New Hampshire; R. H. Pettit, Michigan; A. G. Ruggles, Minnesota; E. E. Scholl, Texas; A. E. Stene, Rhode Island; C. G. Hewitt, J. B. McLaine, William Lochhead, Dominion of Canada; L. O. Howard, C. L. Marlatt, A. F. Burgess, W. R. Walton, L. H. Worthley, D. J. Caffrey, R. I. Smith, U. S. Department of Agriculture.

The proceedings of the conference will be published at an early date by the New York State Department of Farms and Markets, Division of Agriculture. A copy may be secured by application to Hon. C. S. Wilson, Commissioner of Agriculture, Albany, N. Y.

W. E. B.

Scientific Notes

An Imported Feeder on Stored Peanuts. While inspecting warehouses for the State Food Administrator, a heavy infestation of a moth, resembling *Ephestia kuehniella*, was found in peanuts imported from China. About five hundred tons of peanuts had been stored on this floor for six months. The bags were piled about ten deep, while the infestation was confined mostly to the two or three upper layers. Many of the sacks in the upper tier were completely covered by the silken web which the caterpillar spins, in this way also resembling the Mediterranean flour moth. The loss, as with most insects attacking stored foods, came not alone in the destruction of the peanut kernel but in the large amount of frass and webbing present on the uneaten nut. Both hulled and unhulled peanuts were attacked. The deterioration was so marked that the attention of the State Food Inspector was called to the infestation and he promptly confiscated the most heavily infested portions.

The larvæ pupated between the sacks or on the walls and ceilings, there being apparently two or more generations through the summer. Caterpillars pupating in October did not emerge in the laboratory until the first part of April.

The male moth is 10 to 12 mm. long, light gray in color, with a yellowish brown stripe 4 to 5 mm. long in the center and lengthwise of the wing. A distinct black spot is found at the posterior end of this stripe. The female moth is 15 to 16 mm. long, a uniform grayish color, distinctly lighter than *E. kuehniella*. The fore wings show no other markings except a deep black spot about 8 mm. back from the base of the wing. The larvæ are of the same general appearance as *E. kuehniella*.

This moth was identified by Mr. August Busck as *Aphomia* (*Paralipsa, Melissoblates*) *gularis*, Zeller of the family *Galleridæ*. It was described (Horae. Soc. Entom. Rossicæ, vol. xiii, p. 74, pl. 1, fig. 26, plate 2, fig. 27, 1877) from Japan and recorded from China, India and Valdivostock. He comments as follows, "It is presumably a scavenger, feeding in the decayed peanuts and it might well prove of some economic importance if it was introduced into the United States. It is the first record of its coming to our shores as far as I know."

E. R. DE ONG, *University of California.*

The Imported Red Spider (Paratetranychus pilosus Can. & Fanz.) Attacking Apple Foliage. This mite has been reported from Canada by Mr. L. Caesar but has not hitherto been recorded from the United States. Specimens of this mite were kindly determined by Dr. H. E. Ewing through the courtesy of Dr. A. L. Quaintance. The European plum seems to be its preferred host, although it has been found, according to Caesar, on apple, sour cherry, pear, peach, hawthorn, mountain ash and rose. It has become established on apple in Adams County, Pennsylvania. Specimens have been taken from widely separated orchards throughout the county. The foliage of infested orchards becomes brownish or yellowish in color and presents a very sickly appearance. Reports of similar injury have been received from Franklyn County, Pennsylvania, which may prove to be caused by the same species.

Injury by this species was first noted during the summer of 1918, although the owner of one orchard states that he has noticed similar injury for the past three or four years. During the winter of 1918–1919 the eggs were found very abundant in orchards where the injury had been serious the previous summer. The smaller branches were covered with eggs, especially on the under sides, giving the branches a reddish color and attracting the attention of many. In the spring the first reports were received from laborers, working in orchards, who were annoyed by the abundance of these mites and the tickling sensation produced by those which had fallen from the trees.

The mite, on first glance, looks like *Tetranychus bimaculatus* but can readily be separated from this species by the fact that in *P. pilosus* Can. & Fanz., the bristles arise from prominent tubercles.

S. W. Frost, *Research Laboratory, Arendtsville, Pa.*

European Corn Borer (*Pyrausta nubilalis* Hubn.). The past few weeks have demonstrated that but one generation of this pest will occur this year in the known New York infested area. This, if it proves to be normal, means a greatly reduced probability of injury for much of the corn growing area of New York state, though in the warmer parts, for example south of Poughkeepsie, no such exemption from a second brood with probable serious losses can be expected. This not altogether unanticipated development has little bearing upon the behavior of the insect in the corn belt where the longer season is favorable for presumably two and possibly three generations with accompanying serious injuries. An infestation in New York territory, even if there be but one brood, is a constant menace because of the opportunities for spread.

The recent discovery at North Collins, Erie County, of a corn borer now identified as *Pyrausta nubilalis* means an infestation three hundred miles west of anything heretofore known to exist. It also suggests the possibility of the moths having been carried by railway trains, since this infestation is within five miles of the Lake Shore Michigan Southern Railway. The Schenectady area is traversed by the main line of the New York Central and also has near its center Rotterdam Junction with direct railway service over the Boston and Maine from the older infested area near Boston, Massachusetts. There is fair to good railway service between the three points. The recent find and the relationship existing between the occurrence of the insect and railways is worthy of careful consideration.

E. P. Felt.

ANNUAL MEETING, AMERICAN ASSOCIATION OF ECONOMIC ENTOMOLOGISTS

St. Louis, Mo., December 31, 1919 to January 1 and 2, 1920

The 32nd Annual Meeting of this Association will be held at St. Louis, Mo., on the above-mentioned dates. Notices have already been sent to members with a request for titles of papers which they may wish to present at this meeting. Titles must be in the hands of the secretary by November 8, in order to have a place on the program. Applications for membership may be secured from the secretary or from the chairman of the Committee on Membership. It is desired that all applications be filled out, endorsed, and placed in the hands of the chairman of that committee prior to the time of the meeting. It is hoped that the forthcoming meeting at St. Louis will be largely attended, and that it will be one of the best meetings the association has held for many years.

A. F. Burgess, *Secretary.*

Dr. Edna Mosher, recently of the Ohio State University, has accepted a position in the Department of Biology, University of New Mexico, Albuquerque, N. Mex.

JOURNAL OF ECONOMIC ENTOMOLOGY

OFFICIAL ORGAN AMERICAN ASSOCIATION OF ECONOMIC ENTOMOLOGISTS

OCTOBER, 1919

The editors will thankfully receive news items and other matter likely to be of interest to subscribers. Papers will be published, so far as possible, in the order of reception. All extended contributions, at least, should be in the hands of the editor the first of the month preceding publication. Contributors are requested to supply electrotypes for the larger illustrations so far as possible. Photo-engravings may be obtained by authors at cost. The receipt of all papers will be acknowledged —Eds.

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The European corn borer conference at Albany and Boston suggested to some of the older men the summer meetings of years ago, except that it was held a little later in the month and was limited to the consideration of one insect and its associated problems. The summer meeting affords an opportunity to learn at first hand concerning local problems, and the advantages accruing should not be limited, as has been the case during recent years in the eastern United States, to such infrequent occasions as a general consultation concerning a pest of major importance. It is suggested that the matter be kept in mind, since conditions may make it possible to have an occasional summer meeting with some other group of scientists or, if this is not feasible, there might be a smaller gathering to serve the special interests of one section of the country.

The informal session of entomologists held at Albany the evening of August 28 resulted in a better general understanding of policies, though it did not appear to the writer that there was much real difference in opinion. It was more a question of the use of words and the desirability of being explicit in stating limitations. No one conversant with the difficulties incident to control and extermination work with insects could object to such an attitude, and judging from conversations and correspondence since the conference, the resolutions as adopted represent very fairly the consensus of opinion.

Since the St. Louis meeting promises to be unusually important, there should be a large and representative attendance. Changes of fundamental importance in relation to the organization of the Association will be presented for final action. Their import should be understood by all before a vote is taken. The effects of profound social and

economic changes are making themselves manifest and readjustments accompanied by searching scrutiny are bound to occur. Some of these will have a vital bearing upon the professional man. Adequate compensation is as essential in science as in other lines. The recent demonstrations of the power of organized effort have opened new fields of usefulness and increased responsibility accordingly. Have these developments any relation to entomological problems? If such be the case, how can they be utilized? Have the broader phases of entomology received due attention? Can plans be developed which will result in the more comprehensive handling of the numerous problems constantly brought to the attention of the economic entomologist?

Reviews

Class Book of Economic Entomology, with Special Reference to the Economic Insects of the Northern United States and Canada, by William Lochhead, Philadelphia: P. Blakiston's Son & Co., p. i–xiv, 1–436, 257 text figures, 1919. Price, $2.50 net.

The author has condensed in this volume a large amount of information, and deals with the subject in a most comprehensive manner. The first part discusses with the structure, growth and economics of insects, fundamental matter of great importance to the student or individual interested in some phase of insect control. The second and third parts are devoted to insects affecting various crops. Part two, a tabulation designed to facilitate the identification of the pest through its operations, is a most valuable feature. The individual accounts of pests in part three are grouped systematically and only the essentials are given for each species. The identification of the difficult aphids or plant lice is made easier by a brief key to the chief economic genera and a partial list of species having two plant hosts. The author has not hesitated to add other keys where desirable. Part four is limited to a discussion of control methods, insecticides and the utilization of parasitic insects. There is also a well chosen bibliography and a glossary.

The volume, while designed particularly for the classroom, will prove extremely serviceable to many desirous of obtaining a comprehensive idea of insect life. There is an excellent series of illustrations (*Advt.*). E. P. F.

NOTICE CONCERNING BACK NUMBERS OF THE JOURNAL

After January 1, 1920, the price of all back numbers of the Journal of Economic Entomology will be $3.50 per volume, or 75 cents per single number. The supply of Volume 1 is exhausted, but single numbers of this volume that remain on hand can be furnished for 75 cents a copy. Prior to the first of January, 1920, back numbers can be secured at the present rate of $2.50 per volume or 50 cents per copy. This rate does not apply to copies of Volume 1, which will be sent at the rates quoted above.

Bank's Index to the Literature of Economic Entomology can be furnished for $5.00 a copy. Fifty cents additional should be added to the price of each volume or copy of Bank's Index, if shipment is to be made to foreign countries. Anyone needing back numbers will do well to purchase them before the end of the year.

A. F. Burgess, *Secretary*.

Melrose Highlands, Mass.

Current Notes

Conducted by the Associate Editor

Mr. S. Marcovitch has accepted a position with the Tennessee State Board of Entomology as research assistant.

Mr. George G. Becker has been appointed chief inspector of the Arkansas State Plant Board, vice J. Lee Hewitt, resigned.

Mr. Thomas L. Guyton has resigned from the Bureau of Plant Industry of the Department of Agriculture of Pennsylvania.

Mr. Stanley B. Freeborn has returned from service and has been appointed assistant professor of entomology in the University of California.

Mr. F. B. Paddock has resigned as state entomologist of Texas to take effect September 15, to assume the duties of state apiarist of Iowa.

Mr. C. C. Hamilton resigned August 1 as extension entomologist of the Missouri Agricultural Extension Service to enter commercial work.

Miss M. E. Stehle, assistant professor in Zoölogy and Entomology, Clemson College, spent the summer at Woods Hole doing advanced work.

Dr. H. E. Ewing has spent the summer season in the U. S. National Museum doing systematic work on the mites for the Bureau of Entomology.

Mr. T. T. Haack, formerly deputy inspector in Wisconsin, is acting as assistant state leader in charge of barberry eradication in the same state.

A field laboratory has been established by the Ohio Station in the trucking district at Marietta, Ohio, in charge of Mr. W. V. Balduf during the summer.

Mr. W. H. Hambleton returned this month to his position as instructor in entomology and apiculture in the College of Agriculture, University of Wisconsin.

Mr. G. M. Anderson, formerly extension entomologist at Clemson College, has accepted a position as research entomologist, beginning his duties on August 1, 1919.

Mr. Edmund H. Gibson has resigned from the Bureau of Entomology to take up professional work in entomology with headquarters for the present at Alexandria, Va.

Mr. C. R. Phipps, a graduate of the Massachusetts Agricultural College, has been appointed assistant entomologist of the Agricultural Experiment Station at Geneva, N. Y.

Messrs. P. G. Plumley and J. L. Wood, Jr., have recently been added to the corps of nursery and orchard inspectors, working under the Tennessee State Board of Entomology.

Experimental apiary work has been inaugurated in the Entomological Department of the Agricultural Experiment Station, College Station, Texas, with Mr. H. B. Parks in charge.

Prof. K. C. Sullivan of the University of Missouri, Columbia, Mo., prepared an educational exhibit of economic insects for the state fair which attracted unusual attention.

Mr. Russell M. Hain has recently been appointed as an expert on insect troubles in the extension department of the Michigan Agricultural College and began his duties September 1.

Mr. B. B. Fulton, assistant entomologist of the New York (Geneva) Agricultural Experiment station, has been appointed assistant professor of entomology at the Oregon Agricultural College.

Dr. Philip Garman of the Maryland Agricultural Experiment Station has resigned to accept a position in entomological research at the Connecticut Agricultural Experiment Station, New Haven, Conn.

Mr. W. A. Thomas of the State Department of Agriculture, Raleigh, N. C., will resume investigational work with the Bureau of Entomology on truck crop insects and will be stationed at Chadbourn, N. C.

Mr. Harry L. Fackler, who has been an assistant of Prof. S. J. Hunter of Lawrence, Kan., has accepted the position of assistant entomologist for the State Board of Entomology, care University of Tennessee, Knoxville.

Mr. Thomas L. Guyton has resigned as assistant entomologist of the bureau of Plant Industry of the Pennsylvania Department of Agriculture, to complete his work for a doctor's degree at the Ohio State University.

Mr. Frank D. Garrison of Ellijay, Ga., has been secured as the industrial and commercial secretary of the Tennessee State Horticultural Society, with office located with the state entomologist, University of Tennessee, Knoxville.

The Florida legislature at its session just closed, enacted a law providing for the eradication of diseases of honey bees. The execution of the law is placed in the hands of the State Plant Board, and the appropriation is $5,000 per annum.

Messrs. Pierce, Finn, Stear, Buckman and Benn together with some temporary assistants are engaged in scouting in the coal region of Westmoreland, Fayette, Allegheny, Washington and Green counties, Pennsylvania, for the potato wart.

Prof. R. A. Cooley, entomologist of the Montana Experiment Station and state entomologist, after having been in Massachusetts on leave of absence for the summer, has returned to Montana. During his absence Mr. J. R. Parker was in charge.

A caterpillar closely resembling the European corn borer has been found at Ravenna, Ohio. However, from the restricted numbers of the insect, it is hoped that it will turn out to be a native *Pyrausta*. Moths from the caterpillars have not yet been secured.

Mr. M. R. Smith, research assistant in entomology at the South Carolina Agricultural Experiment Station, has accepted a position with the North Carolina State Department of Agriculture as research and extension entomologist and began his duties on August 1, 1919.

Mr. C. L. Marlatt, chairman of the Federal Horticultural Board, delivered addresses before the American Association of Nurserymen at Chicago June 26, and the society of American Florists and Ornamental Horticulturists at Detroit August 21, in regard to quarantine order No. 37.

Dr. H. A. Morgan, formerly entomologist of the Agricultural Experiment Station, and professor of entomology in the University, and more recently director of the Station and dean of the College of Agriculture, has recently been elected president of the University of Tennessee.

Mr. H. E. Woodworth, recently appointed horticultural commissioner of San Mateo County, California, is directing a campaign, now nearly finished, against the horse bean weevil, involving the fumigation of the entire crop of horse beans, amounting to about 3,000,000 pounds.

Mr. G. A. Coleman has returned from a summer school in beekeeping which he conducted at Sur, Monterey County, California. He obtained additional moving picture films representing beekeeping operations and expects ultimately to have a very exhaustive set of these films.

Mr. H. L. Seamans, formerly assistant state entomologist of Montana and recently released from military service, will substitute for Mr. M. H. Spaulding, assistant professor of zoölogy, in the Montana State College of Agriculture and Mechanic Arts during the coming college year.

Mr. N. F. Howard, formerly of the Bureau of Entomology, stationed at Madison, Wis., who has been serving in the Sanitary Corps in France for about a year, returned the first of August and has accepted a position in the Efficiency Department of the Goodrich Rubber Company, Akron, Ohio.

Prof. Leonard Haseman of the University of Missouri, Columbia, Mo., spent the month of August at Ithaca, N. Y., and made a hurried auto trip through a part of the European corn borer, and gipsy and brown-tail moth infested areas of New York, Massachusetts, Rhode Island and Connecticut.

A feature of the past year's work at Clemson College is the activity in extension work for the development of beekeeping. Mr. E. S. Prevost is in charge of this, and a great amount of work was done throughout the state in transferring, requeening and preparations of bees for outdoor wintering.

Mr. L. J. Hogg, formerly assistant in cereal and forage crop insect investigations, Bureau of Entomology, and attached to the laboratory at Tempe, Ariz., died suddenly July 8 of acute peritonitis. At the time of his death, Mr. Hogg was acting as agricultural specialist for a large copper concern in Arizona.

Mr. E. R. De Ong has just completed a survey of the well waters, about 500 wells in the Santa Clara Valley, to determine their hardness for the purpose of prescribing appropriate formulæ for oil emulsions. Great variations were found which accounts for the complaints of the users of this insecticide in that locality.

Mr. Ralph Oertli, Mr. Bernard Iverson and Mr. Jacob Bulger have been appointed assistants in the Entomology Department of the South Dakota State College. Mr. Oertli will assist in the State Experiment Station work, while Messrs. Iverson and Bulger will be connected with the office of the state entomologist.

Capt. R. D. Whitmarsh has resigned his position at the Ohio Station and accepted work with the Corona Chemical Co., Milwaukee, Wis. He will develop a scientific department for the company dealing with entomology and plant pathology. He will also have charge of considerable work, more or less of a commercial character.

Dr. W. Dwight Pierce, who has been connected with the Bureau of Entomology for fifteen years, has severed his connections with the Department and will open up a general entomological consulting and commercial practise with headquarters, probably at Boise, Idaho. His temporary address is 1545 South 19th St., Lincoln, Neb.

Mr. E. O. Essig, who served as farm advisor for Ventura County, California, during the war period and has just held the position of manager of the selling agency for the Lima Bean Growers' Association in which capacity he sold over 250 carloads of beans, has now returned to his professorship in entomology at the University of California.

The following entomologists attended the hearing "On Account of the Flag Smut and Take-All Diseases of Grains and the Wheat Nematode or Eelworm Disease," before the Federal Horticultural Board of Washington, D. C., on July 15: W. J. Schoene, Virginia; Frank N. Wallace, Indiana; A. C. Lewis, Georgia; P. A. Glenn, Illinois.

Dr. William Colcord Woods was granted leave of absence by Wesleyan University for the period of the war. When he returned from France in April he went as member of the summer staff in entomology to the Maine Agricultural Experiment Station at Orono. September 1 he returned to Wesleyan University as assistant professor of biology.

Mr. W. J. Price, who has been connected with the office of the state entomologist in Virginia since 1902, and who for the past eighteen months has been connected with the increased production work in that state for the Bureau of Entomology, has accepted a position in the Department of Agricultural Education, and will be located at Woodstock, Va.

Mr. M. B. Dunn, temporary assistant at the Dominion Entomological Laboratory at Fredericton, N. B., has been appointed an entomological assistant in the Division of Forest Insects of the Entomological Branch, Ottawa, and under the direction of Dr. J. M. Swaine he will be assigned to sample plot investigations in the forests of Quebec and Ontario.

Mr. S. B. Freeborn, since his return from the Army, has been investigating the malaria situation in the northern Sacramento Valley, and is at present directing a campaign in the neighborhood of Anderson to which the State Board of Health has contributed $10,000 in addition to the sum raised by the Mosquito Abatement District organized there.

On August 13, there was held at the State College of Washington, a joint meeting of the horticulturists and entomologists of the northwestern states. The day following, a continuation of this meeting was held at the University of Idaho at Moscow. A year ago, a similar meeting was called at the Oregon Agricultural College which was very successfully attended.

Mr. H. K. Harley of the state entomologist's office, Madison, Wis., spent the week of August 18 to 23 in the neighborhood of Boston, Mass., studying the European corn borer. Mr. Harley is making a survey of Wisconsin, and especially of those areas into which New England seed corn was imported in 1918, to determine if possible whether the corn borer was imported into the state at that time.

A new project dealing with the wire worms affecting wheat has been inaugurated by the Washington Experiment Station in coöperation with the Bureau of Entomology. Frank W. Carlson has been appointed station investigator with headquarters at the Dry-Land Experiment Station at Lind, and F. R. Cole has been delegated by the Bureau of Entomology as collaborator on this work.

The following resignations from the Bureau of Entomology are reported: Geo. A. Hummer, to resume commercial beekeeping; E. W. Scott, in charge of insecticide laboratory, Vienna, Va., to become manager of a newly-formed company, with headquarters at Rockville, Md.; M. D. Leonard, extension entomologist, truck crop insects, New York State, to accept a position at Cornell University Agricultural Experiment Station.

Prof. George B. Neumann recently returned from service in France has been appointed assistant in entomology at the Purdue University Experiment Station,

LaFayette, Ind. Mr. Neumann graduated from the University of Maine in 1914 and received his masters degree at Cornell University in 1915. He was connected with the Department of Entomology, State College of Pennsylvania, for three years before going into the service.

Dr. Charles H. Gage, chemist and metallurgist, and Dr. W. Dwight Pierce, entomologist, have formed the Gage-Pierce Research Laboratories. Their mail address is P. O. Box 1767, Denver, Colorado. It is expected that a number of laboratories will be constructed and a large group of commercial research scientists employed. Entomological control work will be one of the branches of work carried out by the consulting entomologists under Dr. Pierce's direction.

A five day orchard tour was conducted in Kansas, September 1 to 5, by E. G. Kelly, extension specialist, Kansas State Agricultural College, with the following county agents coöperating: W. A. Wunsch, E. J. Macy, W. A. Boys, F. J. Robbins, E. H. Ptacek, H. S. Wilson, J. V. Quigley, I. N. Chapman, A. D. Folker, F. H. Dillenback and O. C. Hagans. The trip included some of the best orchards of the state and not only orchardists, but men in other lines of business were invited.

Mr. S. I. Kuwana, director of the Imperial Quarantine Board of Japan is now in the United States, and inspected the work of the Department of Entomology of the Kansas State Agricultural College September 10. The next day Prof. George A. Dean accompanied Mr. Kuwana to Kansas City, where he was given an opportunity to inspect some of the large flour mills and grain elevators, and to study American methods of handling flour and grain to prevent and control insect injury.

The teaching section of the Entomological Department, Clemson College, S. C., is being considerably strengthened with equipment both in the Zoölogical Laboratory and class room and in the Laboratory of Economic Entomology. The latter work consists principally of the installation of spraying and dusting machinery, temperature moisture control apparatus, fumigation and cold storage and is arranged so as to teach the fundamental principles and not the practice. The course in practical work follows the same line as heretofore.

At the last session of the Washington state legislature, a bill was passed providing for inspection of bees and for educational propaganda regarding beekeeping. The work was assigned to the entomologist of the State College with authority to appoint instructors. Mr. H. A. Scullen, at present extension entomologist on apiculture for the northwestern states, has been designated part-time inspector with headquarters at Pullman. Mr. Scullen will divide his time between extension work, inspection, and instructional work at the State College.

During the season 1918, the Washington Experiment Station in collaboration with the Bureau of Entomology carried on a study of cranberry insects with headquarters at Seaview, Wash. Mr. H. K. Plank was assigned to this work by the Bureau of Entomology and A. Spuler and Miss Orilla E. Miner carried on the work on behalf of the Washington Experiment Station. This year the same project has been continued, the Experiment Station furnishing Miss Flora A. Friese. As evidence of the close coöperation, Mr. Plank and Miss Friese were married June 21.

The following transfers have been made in the Bureau of Entomology: H. A. Scullen, special field agent for Washington, Oregon and Northern Idaho to coöperative work in bee culture with the state of Washington; H. D. Young, California citrus-fruit insect investigations to the Insecticide and Fungicide Board; W. S. Fields, Bureau of Plant Industry to Federal Horticultural Board; R. W. Kelley, experimental field work to take charge of Insecticide and Fungicide Laboratory at Vienna, Va.; E. V. Walter, extension work in Iowa to investigational work at Tempe, Ariz.

Mr. Leonard S. McLaine, M.Sc., of the Canadian Entomological Branch, has been transferred from the Dominion Entomological Laboratory, Fredericton, N. B., to Ottawa, and has been appointed chief of the Division of Plant Inspection and executive assistant to the Dominion entomologist. As chief of the Division of Plant Inspection, Mr. McLaine will have immediate charge of the work of inspection and fumigating imported nursery stock, and of the field work against the brown-tail moth in Eastern Canada, and such other duties as the enforcement of the insects and pests regulations under the Destructive Insect and Pest Act may involve.

At the convention of Southern Nurserymen, held at Atlanta on August 20–21, a committee consisting of Messrs. E. W. Chattin of Winchester, Tenn., Charles Smith, Augusta, Ga., Henry Chase, Chase, Ala., and Professors George C. Starcher, Auburn, Ala., A. C. Lewis, Atlanta, Ga., and G. M. Bentley, Knoxville, Tenn., was appointed by the association to frame rules and regulations pertaining to the uniform inspection laws of nurseries. This committee held a very important meeting and framed the rules and will meet with the federal horticultural inspectors at their annual meeting in December. It is to be hoped that a uniformity of inspection laws may be perfected at that time.

Dr. W. Dwight Pierce has edited and revised the series of lectures on the entomology of disease, hygiene and sanitation and has added several new chapters to form a volume entitled "Sanitary Entomology," which will be published by Richard G. Badger of Boston. The proceeds of the royalties will be given to the Washington Entomological Society. Advance orders for the volume which will sell at $10 are desired in order to cover a guarantee made to the publishers. These are lectures by ten specialists, and the work represents the very latest official information on the subject. Doctors and sanitarians will be as much interested in this volume as entomologists and zoölogists.

New appointments have been made in the Bureau of Entomology as follows: George H. Rea, apicultural extension New York state; Emory G. Shanks, temporary laboratory helper, tropical and subtropical fruit insect investigations; John H. Harmon, Thomas F. Murphy, Roger J. Chambers, H. E. Partridge, Arnold F. Leamy, Earl D. Lathrop, European corn borer investigations; Lee Roy Wilbank, George Lee Lott, H. C. Young, B. F. Ware, G. A. Hammett, James Benford Pope, George W. Alexander, Lloyd W. Brannon, Clarence H. Brannon, James P. H. Clayton, Amos L. Williamson, George S. Fricke, Ben Matt Davenport, temporarily to boll weevil laboratory; Ernest L. Chambers, green house insects.

A coöperative agreement has been perfected between the Wisconsin State Department of Agriculture, the Agricultural Extension Service of Wisconsin, and the U. S. Bureau of Entomology, whereby Mr. H. L. McMurry is to become extension field agent and apiary inspector in that state. The educational and extension work will be conducted by Mr. McMurry under the direction of Prof. H. F. Wilson, entomologist of the Experiment Station; and the apiary inspection, as well as the educational work concerning the control of bee diseases, under the direction of Dr. S. B. Fracker, acting state entomologist. The last legislature passed a new apiary inspection law, placing its administration in the hands of the state entomologist, and requiring, in addition to the usual provisions of such laws, that permits be secured from the state entomologist for the sale or transportation of any bees or used apiary appliances.

Mailed October 22, 1919.

EXCHANGES.

Exchanges or Wants of not over three lines will be inserted for 25 cents each to run as long as the space of this page will permit; the newer ones being added and the oldest dropped as necessary. Send all notices and cash to A. F. Burgess, Melrose Highlands, Mass., by the 15th of the month preceding publication.

BACK NUMBERS WANTED.

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AMERICAN ASSOCIATION OF ECONOMIC ENTOMOLOGISTS
MELROSE HIGHLANDS, MASS.

ENTOMOLOGISTS' EMPLOYMENT BUREAU

Conducted by the American Association of Economic Entomologists.

This Bureau will register Entomologists wishing to secure positions. Station Entomologists and institutions desiring to secure assistants are invited to correspond with the undersigned. Enrollment in the Bureau, $2.00. Fee not returnable.

DR. W. E. HINDS,
Auburn, Alabama.

WILL PAY $1 each for Insect Life, Vol. IV, Nos. 11 and 12, Bibliography, N. A. Economic Entomology, Part IV, or General Index Experiment Station Record for Vols. I–XII.

HUGH GLASGOW, Agricultural Experiment Station, Geneva, New York.

WANTED—Systematic and economic papers on the families *Bombyliidae* and *Asilidae.* Mail descriptive list of titles and prices desired. H. R. HAGAN, Utah Experiment Station, Logan, Utah.

WANTED—SYRPHIDAE—from all parts of the world. Will determine on the usual conditions. Address Prof. C. L. METCALF, Ohio State University, Dept. Entomology, Columbus, Ohio.

WANTED—Trans. Am. Entomological Society, Vol. 3; Lintners 3rd Report (1886); Entomological News, Vol. 2, No. 10 (Dec. 1891); Farmers' Bulletins 7, 8, 10, 12, 89, 117, 214, 268, 356, 556, 558, 839, 878, 905, 911.

P. T. BARNES, Department of Agriculture, Harrisburg, Pa.

AMERICAN ASSOCIATION OF ECONOMIC ENTOMOLOGISTS

(Organized 1889, Incorporated December 29, 1913)

OFFICERS

President, W. C. O'Kane, Durham, N. H.

First Vice-President, A. G. Ruggles, St. Paul, Minn.

Second Vice-President (Pacific Slope Branch), H. J. Quayle, Riverside, Calif.

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JOURNAL OF ECONOMIC ENTOMOLOGY

Official Organ of American Association of Economic Entomologists

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MANUSCRIPT for publication should be sent to the Editor, E. Porter Felt, Nassau, Rens. Co., N. Y.

CURRENT NOTES AND NEWS should be sent to the Associate Editor, W E. Britton, Agricultural Experiment Station, New Haven, Conn.

SUBSCRIPTIONS AND ADVERTISEMENTS may be sent to the Business Manager, A. F. Burgess, Melrose Highlands, Mass.

VOL. 12 DECEMBER, 1919 No. 6

JOURNAL

OF

ECONOMIC ENTOMOLOGY

OFFICIAL ORGAN AMERICAN ASSOCIATION OF ECONOMIC ENTOMOLOGISTS

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CONTENTS

THIRTY-SECOND ANNUAL MEETING OF THE AMERICAN ASSOCIATION OF ECONOMIC ENTOMOLOGISTS

St. Louis, Mo., December 31, 1919 and January 1–2, 1920

The thirty-second annual meeting of the American Association of Economic Entomologists will be held in the Soldan High School on December 31, 1919 and January 1 and 2, 1920.

Sessions will open at 10 a. m., Wednesday, December 31. The annual reports of the officers and standing committees, also the report of the new committee on policy, will be presented at this time, followed by the annual address of the president. The meeting of the general association will be continued at 1.30 p. m., and on Thursday at 10 a. m. The sessions on Friday will be held at 10 a. m. and 1.30 p. m. and the final business meeting will take place late Friday afternoon, unless the length of the program makes an evening session necessary.

Thursday evening has been held open so that an informal dinner or smoker can be arranged if the members so desire.

Sectional Meetings

The meeting of the Section on Apiculture will be held at 8 p. m. Wednesday, December 31. The Section on Horticultural Inspection will meet Thursday at 1.30 p. m.

Other Meetings

The annual meeting of the American Association for the Advancement of Science will be held throughout the week, also meetings of many of the affiliated societies. The Entomological Society of America will meet on Monday and Tuesday, December 29 and 30.

Hotel Headquarters

Hotel headquarters for this association will be at the Warwick, 15th and Locust Sts., where the following rates have been secured; single room \$2.00 to \$3.50 per day, double room \$3.00 to \$5.00 per day. A considerable saving can be made by members who are willing to occupy rooms jointly. All rooms are equipped with bath or shower, hot and cold water and circulating ice water. Members are requested to order their rooms at the earliest possible date.

Railroad Rates

Information concerning railroad rates to the meeting should be secured direct from Dr. L. O. Howard, Permanent Secretary, Smithsonian Institution, Washington, D. C.

Official Buttons

Official buttons for members of this association will be furnished to all members who have paid their dues for 1920. Applications for buttons should be made to the secretary at the time of the meeting.

Membership

Application blanks for membership can be secured from the secretary or from members of the committee on membership, and all applications should be made out, properly endorsed, and filed with the membership committee on or before December 31.

Program

Wednesday, December 31, 1919, 10.00 a. m.

Report of the Secretary.

Report of the executive committee,* by President W. C. O'Kane.

Report of the committee on policy, by E. D. Ball, Ames, Iowa.

Report of the employment bureau, by W. E. Hinds, Auburn, Ala.

Report of the committee on nomenclature, by Glenn W. Herrick, Ithaca, N. Y.

Report of the committee on entomological investigations, by George A. Dean, Manhattan, Kan.

Report of the committee on index of economic entomology, by E. P. Felt, Albany, N. Y.

Report of the committee on U. S. National Museum, by J. J. Davis, Riverton, N. J.

Report of the committee on amendments to the Constitution and By-Laws, by P. J. Parrott, Geneva, N. Y.

The committee will report on proposals to amend Article III of the Constitution and Article II of the By-Laws.

Article III of the Constitution reads as follows:

"SECTION 1. The officers shall consist of a President, one Vice-president, and an additional Vice-president for each branch or section, who shall be elected annually, and a Secretary who shall be elected for a term of three years, who shall perform the duties customarily incumbent upon their respective offices and as defined in the by-laws. The above officers shall act as the Board of Directors and shall pass on any urgent matters that cannot be deferred until the annual meeting. The President shall not hold office for two consecutive terms."

* This report will discuss the question of salaries of Entomologists.

The proposal at the Baltimore meeting was to amend as follows:

"SECTION 1. Amend by striking out the second sentence which reads: 'The above officers shall act as the Board of Directors and shall pass on any urgent matters that cannot be deferred until the annual meeting.'"

Add the following section:

"SECTION 2. There shall be a Board of Directors to be composed each year of the President, Secretary, and Editor of the JOURNAL, as *ex-officio*, and five members elected for five years each, one retiring each year. The Chairman shall be elected by the board."

Article II, Section 4, of the By-Laws reads as follows:

"SECTION 4. The publication of the JOURNAL OF ECONOMIC ENTOMOLOGY shall be entrusted to an Editor, an Associate Editor and a Business Manager, nominated by an advisory committee of six members, which latter shall be elected for terms of three years so arranged that two shall be elected annually. The members of this committee shall have an advisory relation to the above constituted Editorial Board."

The proposal at the Baltimore meeting was to amend as follows:

"SECTION 4. The publication of the JOURNAL OF ECONOMIC ENTOMOLOGY shall be entrusted to an Editor, an Associate Editor and a Business Manager, nominated by the Board of Directors. The members of this committee shall have an advisory relation to the above constituted Editorial Board."

"SECTION 5. The Board of Directors shall have as its function the originating and directing of all policies of the association and its various undertakings; the formulation and fostering of great entomological policies for the profession, and the working out of a more perfect coördination of scientific efforts among entomologists and between entomologists and other professions."

Appointment of committees.

Miscellaneous business.

New business.

Annual Address of the President, W. C. O'Kane, Durham, N. H. "The Day's Work."

READING OF PAPERS

"Effect of Storm Phenomena on Insect Activity," by D. C. Parman, Uvalde, Tex. (15 minutes.)

Notes made on activity of insects during storm; barometric pressure, high wind and rainfall.

"The Control of Breeding of Yellow-Fever Mosquitoes in Ant Guards, Flower Vases, etc.," by James Zetek, Ancon, C. Z. (15 minutes.)

"Mosquito Control in a Southern Army Camp," by S. M. Dohanian, Melrose Highlands, Mass. (8 minutes.)

Method and procedure of mosquito control work, with a view to permanent eradication of malarial mosquitoes, at Kelley Field, Tex.

"New Facts Concerning the Habits of the Rocky Mountain Spotted-Fever Tick, *Dermacentor venustus* Banks," by R. R. Parker, Bozeman, Mont. (15 minutes.)

"The Ecology of Certain Insects Which Infest Stored Food Products," by Royal N. Chapman, St. Paul, Minn. (10 minutes.) Lantern.

Factors which influence the abundance of insects in various products and their importance in the control of the insects.

Adjournment.

Program

Wednesday, December 31, 1919, 1.30 p. m.

Discussion of the Presidential Address.

Reading of Papers

"Possibility of Exterminating Certain External Parasites of Live Stock and Poultry," by F. C. Bishopp, Dallas, Tex. (15 minutes.)

"The Extermination of the Pink Bollworm of Cotton in Texas," by Ernest E. Scholl, Austin, Tex. (15 minutes.)

"The Extermination of the Pink Bollworm of Cotton in Texas," by W. D. Hunter, Washington, D. C. (15 minutes.)

"The European Corn Borer Problem," by E. P. Felt, Albany, N. Y. (15 minutes.)

General discussion of local and national aspects.

"The Work of the Railroad Entomologist," by V. I. Safro, Louisville, Ky. (15 minutes.)

"Professional Entomology: The Call and the Answer," by E. H. Gibson, Alexandria, Va. (10 minutes.)

"Commercial and Professional Entomology—The Future of Our Profession," by W. Dwight Pierce, Denver, Colo. (15 minutes.)

Will show wherein modern business life holds out better prospects to the entomologist than the official state, federal, and institutional positions.
A general survey of the possible developments of this new field and some of the qualifications necessary.

"Notes on Poisoning the Boll Weevil," by Wilmon Newell, Gainesville, Fla. (15 minutes.)

Carefully made experiments show that the efficacy of lead and calcium arsenates is not increased by the presence of dew or rain water on the plants.

"Stabilizers for Oil Emulsions," by W. W. Yothers, Orlando, Fla. (5 minutes.)

"Soil Insecticide Tests," by J. J. Davis, Riverton, N. J. (10 minutes.)

Brief summary of miscellaneous soil insecticide tests against *Cyclocephala Anomola?*, *Popillia*, and *Cotinus* grubs.

"Outline of Project Work in Extension Entomology," by E. G. Kelly, Manhattan, Kan. (15 minutes.) Lantern.

"Some Results of the Special Spray Service Conducted in New York State," by C. R. Crosby and R. G. Palmer, Ithaca, N. Y. (10 minutes.)

This paper deals with the organization of an efficient spray service in certain fruit-producing counties of New York state conducted in coöperation with the farm bureaus.

"Two 'Spray Your Orchard Week' Campaigns in Mississippi," by R. W. Harned and O. I. Snapp, Agricultural College, Miss. (8 minutes.)

Organization and results of two spraying campaigns in Mississippi.

Adjournment.

SECTION ON APICULTURE

W. E. Britton, *Chairman.* G. M. Bentley, *Secretary.*

Program

Wednesday, December 31, 8.00 p. m.

Address by the Chairman, W. E. Britton, New Haven, Conn.

Reading of Papers and Discussions

"The Economic Importance of Beekeeping in Entomological Work," by E. R. Root. Medina, Ohio.

"What Some Entomologists Are Doing for Beekeeping," by Kenneth Hawkins, Watertown, Wis.

"Honey Production," by G. A. Koger, Meridian, Idaho.

"Boys and Girls Bee Clubs," by Frank C. Pellett, Hamilton, Ill.

"Adaptation of System to Locality," by Frank C. Pellett, Hamilton, Ill.

Seasons and flora vary so greatly that much skill is necessary to make the most of the possible crop.

"The Relation of Bees to Fire Blight," by H. A. Gossard, Wooster, Ohio.

"Some Old New Phases of Bee Disease," by E. F. Phillips, Washington, D. C.

"Preliminary Notes on the Value of Winter Protection of Bees," by J. H. Merrill, Manhattan, Kan.

Number of hives with a known quantity of honey and a known quantity of bees placed on scales, and daily readings taken for two years indicate that windbreak, plenty of stores, and packing are very essential.

"Beekeeping in the California National Forests," by George A. Coleman, Berkeley, Calif. (3-reel motion picture.)

"Sweet Clover as a Bee Pasturage," by George G. Ainslie, Knoxville, Tenn.

"Arsenical Poisoning of Bees," by W. A. Price, Lafayette, Ind.

An invitation has been received to visit the C. P. Dadant factory and bee yards at Hamilton, Ill., January 3. Details will be announced at this session.

Transaction of business and selection of officers.

Adjournment.

Program

Thursday, January 1, 1920, 10.00 a. m.

Reading of Papers

"Western Twig Pruners," by F. B. Herbert, Los Gatos, Calif. (8 minutes.)

Species concerned, manner of severing twigs, food plants, etc., of several western twig pruners; all beetles.

"The Pacific Oak Twig-Girdler (*Agrilus angelicus* Horn.)," by H. E. Burke, Los Gatos, Calif. (10 minutes.)

Biological notes on a serious enemy of western oak shade trees.

"Distribution of Shade Tree Insects in 1919," by W. O. Hollister, Kent, Ohio. (10 minutes.)

This paper takes up the distribution and abundance of shade tree insects east of the Mississippi River during this season.

"Ten Years of the Oriental Moth," by H. T. Fernald, Amherst, Mass. (5 minutes.)

"The Control of Codling Moth with Spray-Gun, Rod and Dusting Method—Three-Year Tests," by Leroy Childs, Hood River, Ore. (10 minutes.)

"Features of the Codling Moth Problem in the Ozarks," by Dwight Isely and A. J. Ackerman, Bentonville, Ark. (10 minutes.)

Certain phases of the seasonal history of the codling moth vary widely from those of the more northern fruit sections.

"Some Experiences with the Codling Moth," by T. J. Headlee, New Brunswick, N. J. (15 minutes.)

"Field Experiments for the Control of the Apple Maggot," by Glenn W. Herrick, Ithaca, N. Y. (6 minutes.)

A brief outline of previous infestation of these orchards, the spraying mixture used and the results.

"Wild Hawthorns as Hosts of Apple, Pear and Quince Pests," by W. H. Wellhouse, Ithaca, N. Y. (5 minutes.)

An enumeration of the principal pests of these fruits which feed also on hawthorns, and some notes regarding the abundance of these pests on the hawthorns about Ithaca.

"The Oyster-Shell Scale in Illinois," by P. A. Glenn, Urbana, Ill. (10 minutes.) Lantern.

The most prevalent oyster-shell scale in Illinois is not identical with *L. ulmi* and is much more destructive to a number of ornamental trees and shrubs than *L. ulmi*.

"The Plum Web-Spinning Saw-Fly (*Neurotoma inconspicua* Norton McGillivray), Its Life History and Control," by H. C. Severin, Brookings, S. D. (10 minutes.)

The life history of the insect, also the natural and artificial control measures.

"A Preliminary Report on the Use of the Sodium Cyanide and Other Measures for Controlling the Peach Tree Borer," by Alvah Peterson, New Brunswick, N. J. (15 minutes.) Lantern.

The effect of sodium cyanide on peach trees and the larvæ within. New types of protectors and the response of the larvæ to the same. Other notes.

"Some Studies on the Effects of Arsenical and Other Insecticides on the Larvæ of the Oriental Peach Moth," by Alvah Peterson, New Brunswick, N. J. (Read by title.)

"Dust *v.* Spray for Control of Sour Cherry Pests in Pennsylvania," by J. G. Sanders and D. M. DeLong, Harrisburg, Pa. (10 minutes.)

"Results of Spraying and Dusting Experiments in Mississippi for the Control of Peach Pests, Summer 1919," by O. I. Snapp, Agricultural College, Miss. (10 minutes.)

Adjournment.

SECTION ON HORTICULTURAL INSPECTION

E. C. COTTON, *Chairman.* J. G. SANDERS, *Secretary.*

Program

Thursday, January 1, 1920, 1.30 p. m.

Address by the Chairman, E. C. Cotton, Columbus, Ohio.

READING OF PAPERS AND DISCUSSIONS

"Treating Nursery Stock for the Control of San José Scale," by K. C. Sullivan, Columbia, Mo.

"The Present Status of *Aleurocanthus woglumi* Ashby in the Panama Canal Zone," by H. F. Dietz, Washington, D. C.

"Important Foreign Insect Pests Collected on Imported Nursery Stock in 1919," by E. R. Sasscer, Washington, D. C.

"The Japanese Beetle Problem," by J. J. Davis, Riverton, N. J.

"The Japanese Beetle Quarantine Work," by C. H. Hadley, Riverton, N. J.

"Federal Plant Quarantine Work and Coöperation with State Officials," by C. L. Marlatt, Washington, D. C.

Ample opportunity for discussion will be given. In consequence of the enactment of the Federal Plant Quarantine effective July 1, 1919, every state inspection official will welcome Mr. Marlatt's discussion of this subject.

Transaction of business and selection of officers.

Adjournment.

Program

Friday, January 2, 10.00 a. m.

READING OF PAPERS

"Dipping Tobacco Plants at Setting Time for the Control of the Tobacco Flea Beetle," by Z. P. Metcalf, West Raleigh, N. C. (10 minutes.) Lantern.

A summary of the results secured by dipping tobacco plants in arsenical solution at setting time.

"The Work of *Empoasca mali* on Potato Foliage," by P. J. Parrott and R. D. Olmstead, Geneva, N. Y. (10 minutes.)

An account of the results of a number of experiments to determine the character of injuries to potato leaves by the leafhopper.

"Control of the Potato Leafhopper (*Empoasca mali* LeB.) and Prevention of 'Hopperburn,'" by J. E. Dudley, Jr., Madison, Wis. (10 minutes.) Lantern.

Field control of the potato leafhopper by spraying with consequent effect upon "hopperburn."

"The Life History of the Potato Leafhopper," by F. A. Fenton and Albert Hartzell, Ames, Iowa. (15 minutes.)

Life history studies under Iowa conditions.

"What Percent of Tipburn of Potato Is Caused by the Leafhopper," by E. D. Ball and F. A. Fenton, Ames, Iowa. (10 minutes.)

Report of the season's work on the artificial production and prevention of tipburn.

"Injuries to Beans in the Pod by Hemipterous Insects," by Ira M. Hawley, Ithaca, N. Y. (5 minutes). Lantern.

Feeding punctures of sucking insects and the dimple-like deformities which result.

"Data on Life History and Control of the Common Squash Bug," by F. M. Wadley, Manhattan, Kan. (10 minutes.)

"The Strawberry Rootworm Injuring Roses in Greenhouses," by C. A. Weigel and E. L. Chambers, Washington, D. C. (15 minutes.) Lantern.

Adjournment.

Program

Friday, January 2, 1.30 p. m.

Reading of Papers

"Poisoned Baits for Grasshoppers," by W. P. Flint, Urbana, Ill. (10 minutes.)

Results of recent work in Illinois with poisoned baits.

"Organization for Grasshopper Control," by G. A. Dean and E. G. Kelly, Manhattan, Kan. (12 minutes.) Lantern.

The Kansas grasshopper law; organizing of 36 counties; distribution of 7,000 tons of bran mash and the results.

"A Connecticut Corn Field Injured by *Crambus præfectellus* Zinck," by W. E. Britton, New Haven, Conn. (7 minutes.)

A description of injury, the first of its kind ever noticed in Connecticut corn on sod land.

"A Study of the Oviposition of the Corn Earworm with Relation to Certain Phases of the Life Economy and Measures of Control," by J. W. McColloch, Manhattan, Kan. (15 minutes.)

A detailed study of oviposition in the field.

"Broom Corn, the Probable Host in Which *Pyrausta nubilalis* Hubn. Reached America," by H. E. Smith, Arlington, Mass. (10 minutes.)

"The Larger Corn-Stalk Borer *Diatræa zeacolella* Dyar," by R. W. Leiby, Raleigh, N. C. (12 minutes.) Lantern.

Brief life history and suppressive measures.

"The Corn-Stalk Weevil," by G. G. Ainslie, Knoxville, Tenn. (5 minutes.)

Brief notes on the life history and habits of *Centrinus penicellus*, the larvæ of which are very commonly found boring in corn stalks in the southeastern states.

"Notes on the Habits of *Calandra pertinex* Oliv.," by A. F. Satterthwait, Webster Groves, Mo. (15 minutes.)

Host plants, distribution, economic status and life history.

"The Green Clover Worm (*Plathypena scabra*) on Soy Beans," by Franklin Sherman, Raleigh, N. C. (15 minutes.) Lantern.

Account of investigations at two field stations in North Carolina. Life history, parasites, control, etc.

"Life Histories of Some Kansas *Lachnosterna*," by W. P. Hayes, Manhattan, Kan. (15 minutes.)

The result of studies on the life-cycle of seven species of *Lachnosterna* found in Kansas.

"The Chinch Bug in Montana," by J. R. Parker, Bozeman, Mont. (10 minutes.)

First reported occurrence of the chinch bug in Montana with evidence to show that it hibernates as a nymph instead of an adult as in other states.

"The Hessian Fly and Factors Influencing Its Relation to the Wheat Plant," by L. Haseman, Columbia, Mo. (10 minutes.) Lantern.

A discussion of the work of the fly on wheat and those factors which seem to influence the susceptibility of the plant to its attack.

"The Rate of Multiplication in the Hessian Fly," by W. R. McConnell, Carlisle, Pa. (15 minutes.)

The normal rate of reproduction based on egg-counts, with a discussion of the various factors involved in working out a fair average.

Final Business

Report of committee on auditing.

Report of committee on resolutions.

Report of committee on membership.

Report of other committees.

Nomination of Journal officers by advisory committee.

Report of committee on nominations.

Election of officers.

Miscellaneous business.

Fixing the time and place of next meeting.

Final adjournment.

W. C. O'Kane, *President*,
Durham, N. H.

A. F. Burgess, *Secretary*,
Melrose Highlands, Mass.

JOURNAL

OF

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OFFICIAL ORGAN AMERICAN ASSOCIATION OF ECONOMIC ENTOMOLOGISTS

Vol. 12 DECEMBER, 1919 No. 6

THE MIGRATION OF HARMOLITA GRANDIS FORM MINUTUM: AN IMPORTANT FACTOR IN ITS CONTROL[1]

By W. H. Larrimer and A. L. Ford, *Scientific Assistants, Bureau of Entomology, West Lafayette, Indiana*

During the spring of 1919, *Harmolita grandis* was found to be present in unusual numbers throughout the eastern portion of the great wheat belt. It was evident that should no control measures be used, the infestation might develop into a very serious one within a few years.

Because of the fact that the spring form of this species cannot migrate long distances (it being for the most part wingless) rotation of crops has been a long approved recommendation for the control of this important wheat pest. A search of the literature on this subject failed to reveal any definite data concerning the migratory powers of the spring form of this species. In as much as this has a direct bearing upon the kind of rotation that will effectively control this species, and since the writers have obtained definite data along this line, they deemed it worthy of publication.

It is a well known fact that the spring form of *H. grandis*, although wingless, can migrate short distances by its pedal efforts. It is also generally known that this insect hibernates for the most part in the stubble of the previous year's crop. This means that in case wheat is sown adjacent to the stubble of the previous year's wheat crop, the edge of this field will become infested by the spring form, which comes off the stubble. The second generation individuals which are winged and strong flyers, can then emerge from this infested strip and infest the entire field and even adjacent fields. It is the intention of the writers to show by definite data the distance the spring form of this species can migrate and

[1] Published by permission of Secretary of Agriculture.

thus determine the distance that wheat can be sown from stubble of the previous year's crop, without danger of infestation.

The following is the method by which these data were obtained. Wheat fields were selected adjacent to stubble, and samples taken at ten yard intervals from the edge of the field next to the stubble up to 100 yards toward the center. In every case, fields were selected which were in a crop other than wheat the previous year, in order to eliminate possible infestation caused by adults coming from the stubble on improperly plowed soil. Each sample consisted of three linear feet of drill row, each foot taken at an interval of five yards in the same row. These samples were brought to the laboratory and carefully examined, the percentage of culms infested by this species being recorded. In this way the distance the adults migrated from the stubble was definitely determined, it being established by the area of infestation. In all cases the infestation was heaviest adjacent to the stubble and decreased in a regular manner with increasing distance from the stubble.

Samples which were taken from eight fields were carefully examined and infestation percentages recorded. In all 280 linear feet of drill row representing 12,276 culms were handled, each culm being carefully examined to detect the presence of this species. The tabulated data from these examinations are found in the following table:

Table I

Fields	Distance from stubble	Linear ft. drill row counted	No. culms examined	No. culms infested with *H. grandis*	Per cent infestation
8	Next to stubble	26	1,093	133	12.1
8	10 yds.	26	1,204	58	4.8
8	20 yds.	26	1,103	27	2.4
8	30 yds.	26	1,139	18	1.6
8	40 yds.	26	1,156	7	0.6
8	50 yds.	26	1,171	4	0.4
8	60 yds.	26	1,088	1	0.09
8	70 yds.	26	1,038	1	0.10
8	80 yds.	26	1,158	1	0.08
8	90 yds.	24	1,025	1	0.10
8	100 yds.	24	1,101	0	0.0
			12,276		

Note: Samples from field 8 consisted of five linear feet of drill row except at 90 and 100 yards out which consisted of three linear feet.

From the above table and curve it can be seen that the greater part of the infestation occurred within ten yards of the standing stubble, and beyond 30 yards the infestation became practically negligible. The amount of infestation varied markedly in the eight fields, ranging from 20.1 per cent to 6.2 per cent at the stubble, but in every case it decreased in practically the same ratio as the distance from the stubble increased. These data show that under ordinary conditions very few of the wingless

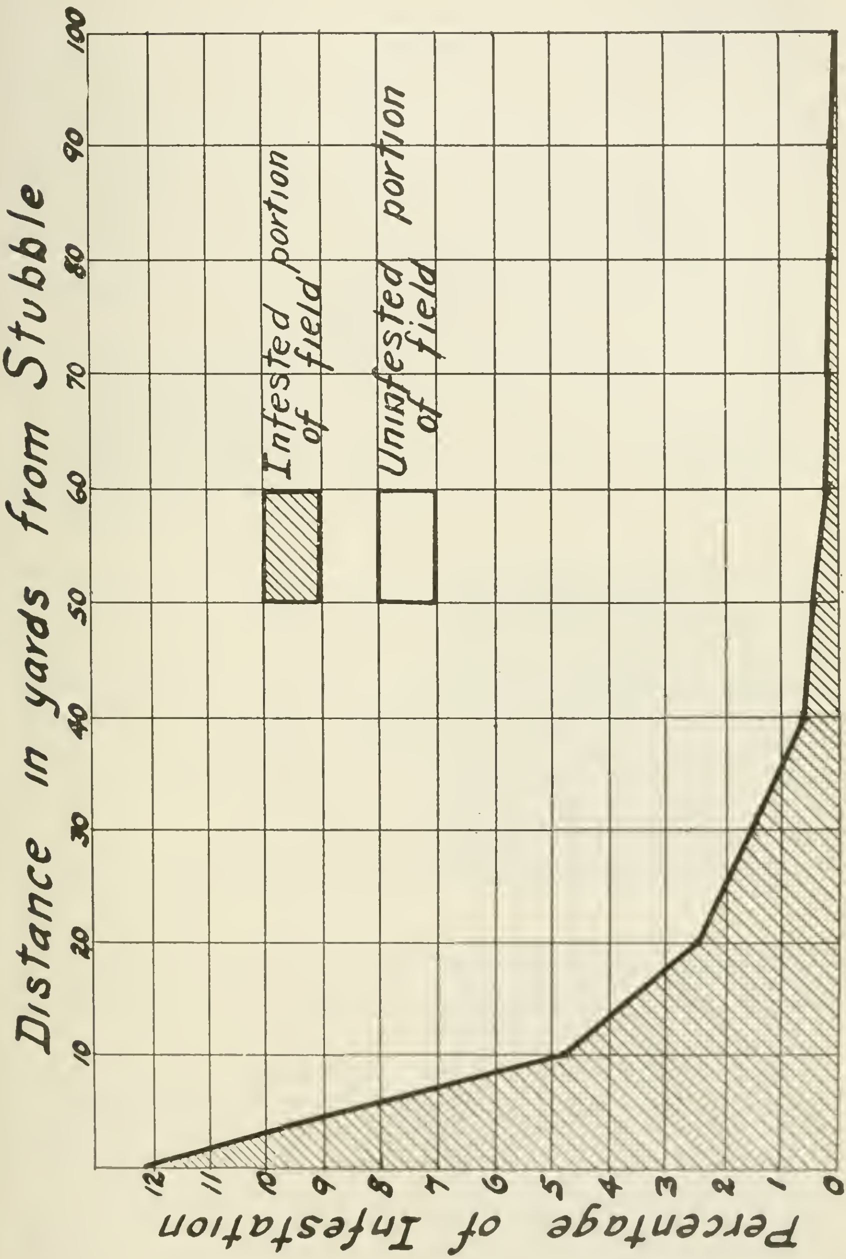


Fig. 21. Curve constructed from the data found in Table I, showing the exact location of the percentages of infestation at various distances from the standing stubble.

adults of this species will migrate farther than 30 yards from the stubble which marked their emerging place.

Several fields which were in wheat the previous year were examined and only a trace of the spring generation of this species was found, and this only where the stubble of the previous year's crop had been improperly plowed. In one field which was in wheat the previous year, a count was taken 100 yards from the edge and showed no infestation; 150 yards showed an infestation of 0.94 per cent and 200 yards, none. From this it can be seen that by far the greater part of the infestation from this generation occurs in those fields which are adjacent to standing stubble of the previous year's wheat crop and within 30 yards of the edge.

Plate 17, 3 of the accompanying figures is an illustration of a plant infested by the spring form of this species. The four tillers on the right are infested. The leaves are broader than normal, darker green, and the center shoot is absent. They appear very much as if they were infested by Hessian fly. The four tillers on the left are normal healthy ones. The isolation of the infestation by the wingless spring generation was very apparent in some of the fields. At the edge adjacent to the stubble the wheat was very thin and dwarfed, which is characteristic of a heavy infestation from this species. Plate 17, 1 and 2 show this condition very well. Both were taken on the same day in the same field only 50 yards apart. Both were focused at the same distance. The first generation infestation was 19 per cent and the second generation infestation 85 per cent at the spot where the first picture was taken. At the location of the second picture there was none of the first generation found but a second generation infestation of about 50 per cent.

An examination of the volunteer wheat in the several stubble fields was made and in every case it was very highly infested with spring generation. Where volunteer wheat is abundant in the stubble fields which are harboring the over-wintering pupæ, it simply acts as a breeding place whereby the wingless first generation can oviposit, thus allowing the strong flying second generation to complete its task of infesting all the wheat in the vicinity.

Having found that practically all of the first brood was located along the edge (outer 30 yards) of wheat fields adjacent to standing stubble, and in volunteer wheat in the stubble, next it was decided to determine to what extent the winged second generation which came from these infested places could infest the wheat in the surrounding vicinity.

Counts were made in the same eight fields for second generation infestation but this time, instead of using ten yard intervals from the stubble, 50 yards were used and only four counts made, namely, next to stubble, at 50, 100 and 150 yards. The counts were made similar to those described above, three linear feet of drill row being taken at three


1


2


3

different places in the same row. Only the culms which had "shot" and were jointed were counted, as it is in these that the adults of the second generation oviposit.

The following table shows the location of the second generation infestation, the percentages being an average of the eight fields:

TABLE II. SECOND GENERATION INFESTATIONS ON THE SAME EIGHT FIELDS THAT THE FIRST GENERATION COUNTS WERE MADE

No. of fields	Linear ft. drill row	Distance from stubble	Tillers counted	Tillers infested	Per cent infestation
8	24	Next to stubble	448	227	50.7
8	24	50 yds.	423	100	23.6
8	24	100 yds.	413	53	12.8
8	24	150 yds.	409	26	6.4

On examining the data obtained from these counts it can be seen that although the heaviest infestation remained in those parts of the fields nearest the standing stubble, comparatively high infestations were found even at 150 yards, which is approximately the middle of most of the fields used in the counts. On the other hand the infestation caused by the first generation stopped at about 30 yards. This shows that the strong flying adults of the second generation will infest an entire field even though they come from a narrow infested strip or a small plot of volunteer wheat in or near standing stubble.

Since it has been shown that the second generation can infest an entire field next to standing stubble, the question now arises, are these second generation individuals able to infest wheat fields which are isolated from standing stubble areas. It has already been stated that practically none of the first generation could be found in last year's wheat which had been properly plowed. It was decided to make second generation counts in fields which were not adjacent to standing stubble. Also to determine the efficiency of plowing under the stubble of the previous year's crop, two types of these fields were taken; those in wheat last year, the stubble having been plowed under, and those in a crop other than wheat the previous year. Since all other conditions in these two classes of fields were practically identical, any marked variation in the percentages of infestation could be undoubtedly due to the fact that it came from the plowed-under stubble in the form of early wingless generation, and hence, on to the second generation infestation.

The counts were made in the following manner: Three linear feet of drill row were taken at five-yard intervals in the same row, these samples being taken at four places in each field, at the edge, 50 yards, 100 yards and 150 yards from the edge. The samples were taken to the laboratory and each culm carefully dissected and infestations recorded.

The following curves show in a graphic way how the winged second generation greatly increases its area of infestation over the area infested by the first generation. The curves represent the infestation of eight fields by both generations and are platted with equal value.

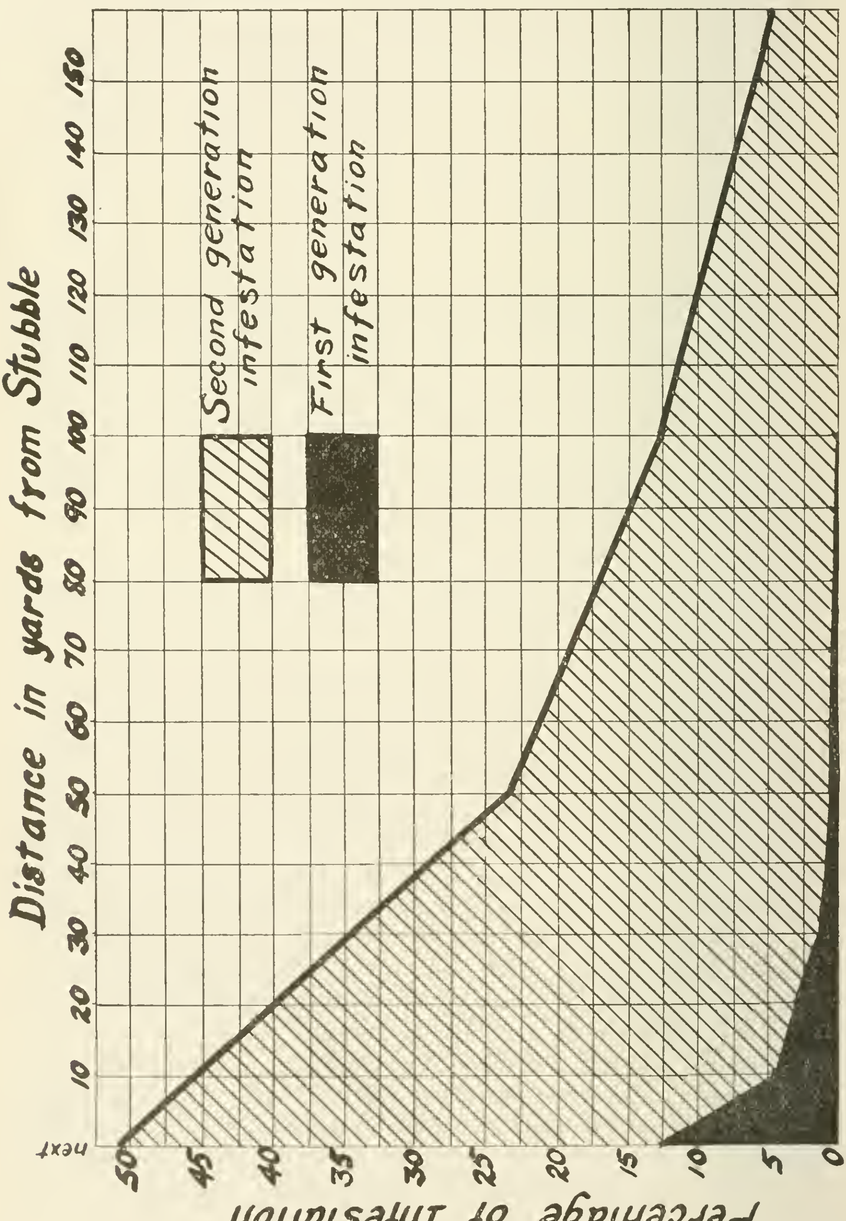


Fig. 22. Curves based on Table II.

Data were taken from seven fields which were in wheat last year but not next to standing stubble. The results are found in the table following:

TABLE III. SECOND GENERATION COUNTS ON SEVEN FIELDS IN WHEAT LAST YEAR BUT NOT NEXT TO STANDING STUBBLE

No. of fields	Linear feet	Distance from edge	Tillers counted	Tillers infested	Per cent infestation
7	21	At edge	318	45	14.1
7	21	50 yds.	365	34	9.6
7	21	100 yds.	367	57	15.5
7	21	150 yds.	374	25	6.7
			Total 1,414	161	Average 11.6%

The above table shows that the infestation, although markedly lighter than in fields adjacent to standing stubble, was fairly uniform throughout the fields.

Similar data were taken from eight fields which were in a crop other than wheat last year and at the same time not next to standing wheat stubble. The results from these eight fields are found in the following table:

TABLE IV. SECOND GENERATION COUNTS ON EIGHT FIELDS NOT IN WHEAT LAST YEAR AND NOT NEXT TO STANDING STUBBLE

No. of fields	Linear ft. drill row	Distance from stubble	Tillers counted	Tillers infested	Per cent infestation
8	24	At edge	458	64	13.9
8	24	50 yds.	465	50	10.7
8	24	100 yds.	498	34	6.8
8	24	150 yds.	498	47	9.6
			Total 1,919	195	Average 9.9%

Again the infestation was fairly uniform throughout the field. Although these fields were not in wheat last year nor next to standing stubble, the infestation from this species was practically the same (very slightly less) as fields on plowed wheat stubble. This is shown in the accompanying graph.

The fact that there was no great difference in the infestation in fields which were and were not in wheat the previous year, that is in fields not adjacent to stubble, tends to show that the plowing under of stubble is fairly efficient in the control of this species. If the first generation adults were able to emerge from plowed under stubble, surely there would be a much greater infestation in those fields which were in wheat last year.

Since we find the ordinary infestation in fields isolated from standing stubble which were not in wheat last year, the question arises "where is the source of infestation in these isolated fields?" This can be answered in only one way. The second generation must come from the first and since practically all of the first generation is found near the edge of the

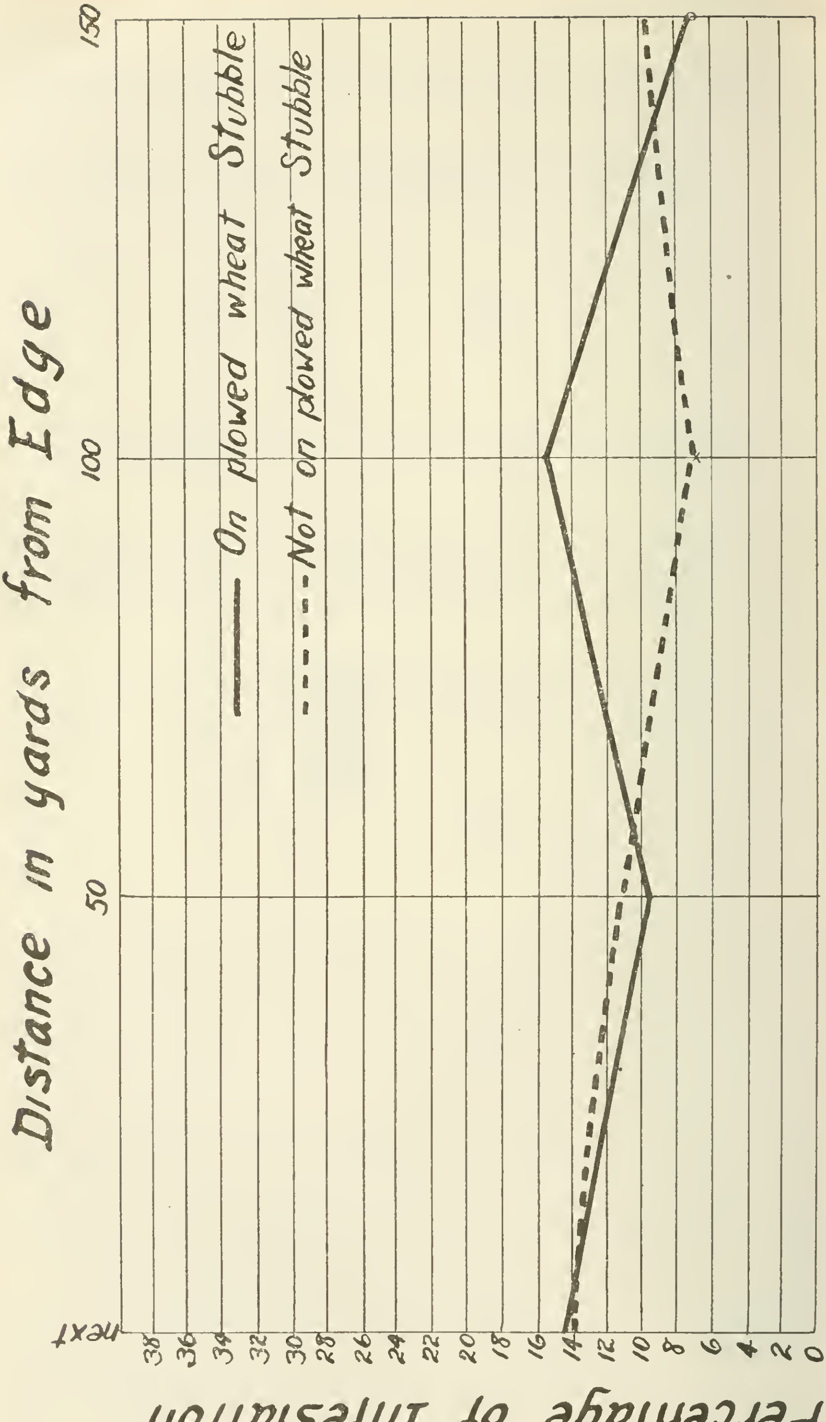


Fig 23. Graph based on Table III.

wheat fields adjacent to stubble or in volunteer wheat in or near stubble, the source of infestation of these isolated fields must originate from these places. These data prove that the winged second generation are strong flyers and emerge from wheat in or very near standing stubble, scatter themselves broadcast, and infest all wheat fairly uniformly over the whole general neighborhood.

Because of the general distribution of the second generation it is certainly not practical to attempt to apply control measures here. The point of attack is certainly in the first generation, the infestation of which is always very limited in area.

It has already been stated that the plowing under of stubble is effective in preventing further infestation from this species. This is one more reason added to the list why wheat stubble should not be left standing after harvest any longer than possible. In some cases, however, farmers find it impossible to plow under the stubble. In this event, wheat should not be sown adjacent to this infested stubble as shown by the facts already set forth. In the data compiled in Table I, it is seen that practically none of the first generation will migrate more than 30 yards to oviposit. This is the key to the whole situation. By planting wheat not closer than 30 yards to standing stubble, one is fairly safe from infestation. Where the stubble can be thrown under without plowing up a hay crop, it should be, but where the hay crop is to be left with the stubble, the following year's wheat should not be sown within 30 yards of it. If it should be, it will act merely as a breeding place for the first generation and the resulting winged second generation will then infest the whole field and nearby fields as well, as is clearly shown by the data embodied in this paper.

It is also essential to keep down all volunteer wheat in or near stubble. This is most apt to spring up around old shock bottoms. This volunteer wheat will act as a breeding place exactly as will wheat sown next to stubble.

Summary

In summarizing the data set forth in this paper, the writers wish to emphasize the following points: Should *H. grandis* increase at its present rate, a great deal of damage will result in the wheat growing region of the United States. The pest hibernates in the stubble and the wingless first generation will infest adjacent wheat or volunteer wheat in or near standing stubble, as it affords a breeding place whereby the first generation can survive, thus exposing the entire neighborhood to infestation from the strong flying second generation. Should the wingless first generation be deprived of its natural breeding places, namely the edge of wheat fields adjacent to standing stubble and volunteer wheat in or near stubble, the result will undoubtedly be a great decrease in the amount of infestation during the succeeding seasons.

NOTES ON THE BRONZE APPLE-TREE WEEVIL[1]

By G. F. Moznette,[2] *Entomological Inspector, Bureau of Entomology, United States Department of Agriculture*

Introduction

The bronze apple-tree weevil, *Magdalis ænescens* Lec., is prevalent throughout the Willamette Valley in Oregon. This is true particularly in vicinities where trees which this species attacks have been neglected or for some cause are devitalized and gradually dying. This species has not been observed attacking healthy trees, but where a tree is slowly dying from some cause, this species generally attacks it and hastens the death.

History and Distribution of the Species

The species was first described by Dr. LeConte[3] in 1876 from specimens presented him by Mr. Ulke collected in Oregon. In 1898 Dr. James Fletcher[4] reported having received specimens from apple boughs containing the larvæ of this insect from Victoria and Nanaimo, British Columbia, and proposed the name bronze apple-tree weevil for it. In 1900 Dr. F. H. Chittenden[5] published an account of this insect from investigations made of material received from the state of Washington where the insect was thought associated with the "Black Spot" or canker, a fungus disease caused by *Macrophoma curvispora* Peck. This report also contains biological notes by Prof. C. V. Piper then connected with the Agricultural Experiment Station at Pullman, Washington, and he states that the insect injury was apparently secondary to the fungus disease mentioned above. In 1911 H. F. Wilson published notes on this species stating further occurrence in the state of Oregon.

Records of this species by Dr. Chittenden shows the distribution to be Sunnydale, Puyallup, Tracyton, Vancouver, Sedro and Woolley in Washington; Salem, Hood River, and Corvallis in Oregon; Victoria, Nanaimo and Gabriola Islands in British Columbia. In addition to the above localities the writer wishes to add the following: Liberty, Eddyville, Portland, Turner and McMinnville in Oregon.

Host Plants

In no case has the writer observed this species infesting healthy trees. The trees are injured in some way, either due to winter killing or to the

[1] Published by permission of the Secretary of Agriculture.

[2] Formerly Research Assistant in Entomology at the Oregon Experiment Station.

[3] Proc. Amer. Phil. Soc., Vol. XV, p. 192.

[4] Rept. of Ent. and Bot., 1898, Canada.

[5] Bul. 22, Bureau of Entomology, p. 36 (Misc. Results).

attacks of some disease; any general deteriorated condition of the trees promotes the attacks of the weevils. The species was taken from apple, Cratægus and Italian prune trees. During the early part of 1916 while at McMinnville, Oregon, this species was observed in numbers in Italian prune wood. This wood had been sawed from orchard trees killed apparently through the attacks of the peach and prune root borer, *Aegeria opalescens* Edw., a destructive insect to peaches and Italian prunes in that section of Oregon. As the trees were grubbed out during the winter, they were apparently infested while in the orchard, the weevils developing in the wood after it was sawed.

The species was found in many apple trees in the vicinity of Corvallis, Oregon, but only in dead or nearly dead areas of such trees. It has not been found by the writer to be associated with any canker but later found that the attacks of the weevils were only secondary.

Notes on Seasonal History and Habits

On April 15, 1916, the writer obtained several large apple limbs from a tree located near Corvallis, Oregon, growing in the center of a stream. The tree was greatly devitalized and only the more seemingly healthy areas bordered with the dead wood showed the presence of the insect. In these particular limbs a few of the areas could be found containing egg punctures of the previous season. Upon examination the portion underneath the bark and next to the wood was found furrowed with channels running in every direction (Plate 18, figs. 4, 5) and revealed the presence of many pupæ and larvæ of this species. Some were just transforming to adults and changing color. The beetles (Plate 18, fig. 1) on emerging are at first a very light brown changing on exposure to a blackish bronze color. The description of the adult by Dr. LeConte is as follows:

> Elongate, black bronzed, slightly pubescent, head, beak and prothorax densely finely punctured, the last longer than wide, rounded on the sides, which are serrate in front; hind angles small, prominent, base bisinuate, disc subcarinate in front of the middle. Elytra obliquely impressed behind the base, and also behind the middle; striæ composed of not very large punctures, interspaces finely rugose. Mesosternum not protuberant; thighs acutely toothed, claws distinctly toothed near the base. Length, 3.7–5.6 mm.; .15–.22 inch.

On April 15, 1916, very few larvæ were to be found and no doubt most of the larvæ had transformed from the first of April until about the tenth. Seasonally this will vary considerably with the weather conditions.

The larva (Plate 18, fig. 3) before pupation excavates an oval cell between the bark and wood at the end of the burrow. It is legless, white in color and the body is considerably wrinkled. The body is larger in the prothoracic region and in this way differs somewhat from the ordinary Curculionid type of larva. The mouth parts are brown and small.

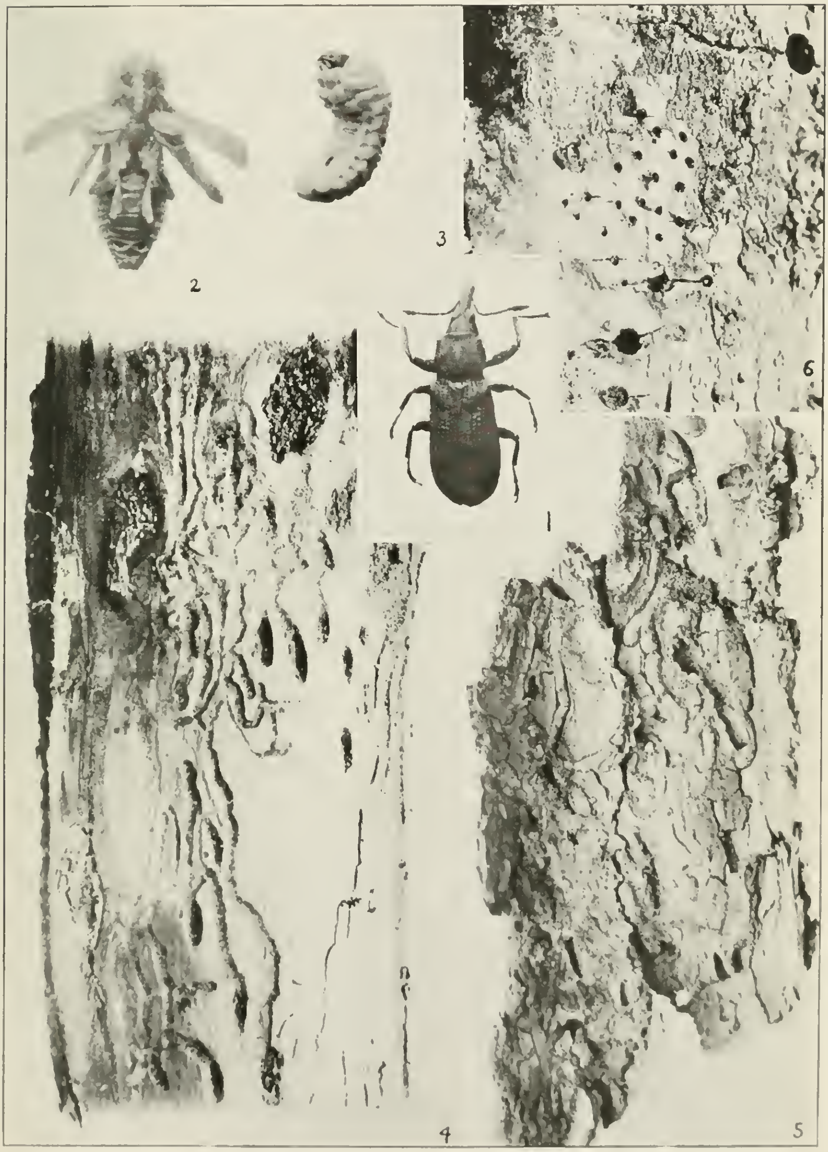
Before pupating the larva lines the oval cavity (Plate 18, fig. 4) with frass in which it pupates. When the larva transforms into the pupal stage (Plate 18, fig. 2) one may see the resemblance which it has to the adult beetle. The head and snout are bent down over the thorax along the ventral side of the body and is white in color. The pupal stage lasts approximately five days, depending on the weather conditions. On April 24, 1916, many adults had emerged from the pupal stage and were feeding on the foliage. On the foliage they eat out peculiar round holes about the size of the end of the rostrum, some leaves appeared riddled with these small circular cut places. The species was observed to feed particularly on the upper surface of the leaves.

On the morning of April 25, 1916, observed several females in the act of depositing eggs in the bark. For egg deposition the females do not ordinarily prefer the smooth bark but instead seek the more roughened areas. The rostrum is used to burrow the cavities to receive the eggs. The rostrum being curved the female is able to cut out a sort of chamber underneath the bark by turning the beak around. After the excavation is completed the female turns about and deposits the egg. The egg is very small, a little over $\frac{1}{2}$ mm. in length, is yellow, shining and globular in shape. After depositing the egg the female forces it into the cavity by means of the rostrum and usually the cavity is sealed with frass. A number of cavities may be found arranged in a circular mass (Plate 18, fig. 6). The number of egg cavities in one mass was observed to range from four to twenty-one. According to Prof. C. V. Piper the different egg cavities in each group are burrowed at different times; at least in all the cases observed by him the beetle went away after digging one cavity and laying her egg therein. The writer's observations show that a female burrowed a maximum of four cavities in one place at a time and then left.

The adults do not live very long after egg deposition and in the cages it was observed that the beetles showed a disposition to kill each other. The eggs which were deposited on April 26, 1916, had all hatched on May 14 and 15, 1916. The larvæ upon emergence immediately burrow in any direction in the bark close to the wood (Plate 18, fig. 4) or just on the surface including a little of the wood as they tunnel. The burrow is at first very small, measuring a half millimeter and when completed about two millimeters. The larvæ live over winter feeding on the bark and on the surface of the wood next to the bark, transforming again in the early part of April. The length of the larval stage is approximately ten to eleven months depending on the weather conditions in the spring.

Parasites

The large limbs which were obtained on April 15, 1916, were found on examination to contain numerous specimens which were parasitized.



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3
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1
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5

The number of parasitized individuals averaged 50 per cent. There were two species of parasites which were from the larvæ and pupæ. These were determined for me by Mr. H. S. Smith as a (Chalcidoidea) *Tetrastichus* sp. and a (Braconid) *Calyptus* sp. The primary parasite was not determined and it is possible one is a hyperparasite. The writer also found quite a number of larvæ of some Coleopterous insect which resembled a Dermestid.

Explanation of Plate 18

Fig. 1, the adult weevil.

Fig. 2, the pupa.

Fig. 3, the larva or grub.

Fig. 4, section of apple limb with bark removed showing channels of larvæ and pupal cells.

Fig. 5, section of bark removed from limb showing channels of larvæ and pupal cells.

Fig. 6, section of bark showing egg punctures or cavities where eggs are laid and the emergence holes of the adults.

THE BENEFICIAL ACTION OF LIME IN LIME SULFUR AND LEAD ARSENATE COMBINATION SPRAY

By R. H. Robinson, *Associate Chemist, Oregon Experiment Station, Corvallis, Ore.*

It is a prevalent custom among horticulturists throughout the country to use combination sprays, that is, mix two spray materials and make the application as a unit whereby the extra expense of making two separate sprayings is saved. If, however, two sprays are so combined that a chemical reaction occurs in which their peculiar insecticidal or fungicidal properties are destroyed or some product of the reaction is formed, that would cause burning of foliage or other injury, the practice in that case should be discouraged. It is probable that where combination sprays have given unfavorable or even harmful results and the cause attributed to poor quality of original materials used, that the actual reason may be due to products formed following chemical reaction between the two sprays combined, when the insecticidal properties are thus destroyed. In many such instances the deleterious action might be partially or entirely prevented by the addition of some inert substance that would retard chemical changes.

We have, by mixing lime sulfur and lead arsenate, one of the most important combination sprays now generally employed. It is plainly evident that both of these sprays immediately begin to change in appearance and a dark precipitate settles out after they are mixed. Owing to the chemical action that occurs in which the insecticidal properties of this combination spray is destroyed to a certain extent, means of overcoming

this difficulty is worthy of especial consideration. As shown by Tartar and Robinson[1] and later by McDonnell and Smith[2] and also by G. E. Smith,[3] there are two lead arsenates, namely, lead hydrogen or acid arsenate, and basic or neutral lead arsenate, that are easily prepared. Both of these are manufactured commercially and sold on the market chiefly for spraying purposes. Since perhaps more than 95 per cent of the lead arsenate sold is the lead hydrogen arsenate, this is the type generally used in combination sprays. When combined with lime sulfur it was observed that the residue from the mixture of the lead hydrogen arsenate was much darker than that obtained with the neutral arsenate, indicating greater decomposition. Consequently a study was made of the changes that occurred when lime sulfur, diluted to summer spraying strength, was mixed with lead hydrogen arsenate and with basic lead arsenate.

Lime sulfur having a specific gravity of 1.259 was diluted at the rate of 1 gallon to 30 gallons of water. To each of several 1000 cc. portions of this dilute lime sulfur solution, 4.8 grams of the different arsenates mentioned were added. The mixture was agitated occasionally during 14 hours, allowed to settle, and the clear lime sulfur siphoned off from the lead arsenate residue. The residue was then transferred to a filter, washed thoroughly with cold water and dried at 60 degrees C. The following table shows the important changes that occurred in the lime sulfur, diluted for summer spraying, and mixed with lead hydrogen and basic arsenate.

Table I. Composition of Lime Sulfur Before and After Addition of Hydrogen and Basic Lead Arsenate

	Lime sulfur only	Lime sulfur and lead hydrogen arsenate, grams per 1000 cc.	Lime sulfur and basic lead arsenate
Lime, CaO	4.2280	3.1880	4.0880
Sulfur, S	8.8004	5.8367	8.7496
Arsenic oxide, As_2O_5	None	.0740	.0014
Lead oxide, PbO	None	None	None

The above results indicate that there is considerable reaction between lime sulfur and lead hydrogen arsenate while the basic lead arsenate caused only a slight change in the lime sulfur. Calculated from the original amount of lead hydrogen arsenate used, over 5 per

[1] Tartar, H. V., and Robinson, R. H. The Arsenates of Lead, Journal of American Chem. Society, Vol. 36, Sept., 1914.

[2] McDonnell, C. C., and Smith, C. M. The Arsenates of Lead, Journal of American Chem. Society, Vol. 38, Oct., 1916.

[3] Smith, G. E. Lead Arsenates, Journal of American Chem. Society, Vol. 38, Oct., 1916.

cent of the arsenic was found in a soluble form thus increasing the tendency to cause burning of foliage and other injury. Furthermore the decrease in the sulfur content indicates excessive loss of that active element. The total polysulfid content was reduced from 8.8004 grams to 5.8367 grams or over 35 per cent. In other words, by mixing lead hydrogen arsenate and summer strength lime sulfur the efficiency of the latter is decreased more than 35 per cent while severe burning of foliage may occur owing to the presence of arsenic as a soluble salt.

The changes that occur in the composition of the lead hydrogen arsenate mixed with the lime sulfur as shown by analyses of the lead arsenate residue likewise emphasize the need for adding some inert material that will diminish the chemical reaction. Table II gives the analyses of both types of arsenates before and after mixing with lime sulfur and treated as described above:

Table II. Analyses of Lead Hydrogen and Basic Arsenate Before and After Mixing with Lime Sulfur

	Lead hydrogen arsenate		Basic lead arsenate	
	Before mixing	After mixing	Before mixing	After mixing
Lead oxide, PbO	63.86%	34.83%	74.70%	72.13%
Arsenic oxide, As_2O_5	32.90%	18.11%	23.41%	22.71%
Lime, CaO	——	12.97%	——	2.42%
Lead sulfid, PbS	——	25.25%	——	.44%

These results substantiate those given in Table I. Both sulfur and lime have been removed from the lime sulfur in the reaction and the lead from the lead arsenate to form sulfide of lead. From the analysis the decrease in the quality of the insecticide is self-evident.

Although the foregoing results show that the basic lead arsenate may be advantageously mixed with lime sulfur, since it is not available, the hydrogen arsenate must be used. Hence the importance of adding some inert material in order to prevent, as much as possible, the devitalizing reaction. During investigations on the calcium arsenate by the writer[1] it was observed that slaked lime, $Ca(OH)_2$, prevented almost entirely any decomposition of both calcium arsenate and lime sulfur when mixed. Consequently it was thought that lime might have a similar effect when used with lime sulfur and lead arsenate combination spray and the reaction tend toward the formation of the basic lead arsenate according to the equation:

$$3\ PbH\ AsO_4 + Ca(OH)_2 = Pb_3(AsO_4)_2 + CaHAsO_4 + 2\ H_2O$$

To this end a study was made using both pure material, prepared in the laboratory, and commercial samples. The lime was obtained by

[1] Robinson, R. H. The Calcium Arsenates, Jour. of Agri. Res., Vol. 13, Apr. 29, 1913.

igniting C.P. calcium carbonate until all carbon dioxide was driven off; lime sulfur was made from recrystallized sulfur and from lime obtained as described above; lead hydrogen arsenate was prepared by the method outlined by Robinson and Tartar.[1] The commercial products used were standard brands found on the market.

The outline of procedure was as follows: The lime sulfur, both laboratory prepared sample and commercial brands was brought to a density of 1.262 or 30 degrees Baume and diluted 1 part to 40 parts of water or summer strength. After slaking with a small amount of water, lime was added at the rate of 10 pounds to 100 gallons. Finally, lead hydrogen arsenate was added at the rate of 2 pounds to 100 gallons or 4.8 grams to 1000 cc., the quantity used in the experiment. In this manner, triplicate portions of each brand of lime sulfur taken were prepared. The mixtures were then shaken occasionally during three hours and after filtration, determinations for soluble arsenic were made. Table III gives the per cent of arsenic found:

Table III. Per cent of Soluble Arsenic in Lime Sulfur Solution from Combination Spray, Treated and Untreated with Lime

	Without lime	With lime
Lab. prepared lime sulfur and lead arsenate	12.90%	0
Commercial sample No. 1, lime sulfur and lead arsenate	12.20%	0
Commercial sample No. 2, lime sulfur and lead arsenate	12.90%	0

It is obvious from these results that the presence of free lime prevents arsenic from going into solution as a soluble salt. On the other hand where no lime was added a usual high per cent of soluble arsenic was found indicating that over 12 per cent of the lead hydrogen arsenate was decomposed, decreasing its efficiency accordingly. Observation on the changes that occurred during the reaction showed that those samples treated with lime slowly turned to a gray color similar to the basic lead arsenate and lime sulfur mixture where the amount of chemical changes was negligible, while those untreated immediately turned black, indicating the breaking down of both lime sulfur and lead arsenate and the formation of lead sulfid.

Change in the polysulfid content of the lime sulfur was likewise studied. The total sulfid content was first determined in the diluted lime sulfur solution, and, after treatment as described above, again determined after shaking at intervals during three hours and again after two days. The table gives the grams contained in 1000 cc. of lime sulfur and lead arsenate mixture.

[1] Robinson, R. H., and Tartar, H. V. The Arsenates of Lead, Ore. Exp. Sta. Bul. 128, 1915.

Table IV. Amount of Polysulfids in Lime Sulfur Treated and Untreated Combination Spray

	After 3 hrs.	After 2 days
Lime sulfur only	4.360 gms.	4.360 gms.
Lime sulfur and lead arsenate	1.892 "	None
Lime sulfur and lead arsenate and lime	4.240 "	3.040 "

Here again the value of adding lime to lime sulfur previous to combining with lead hydrogen arsenate is emphasized. The polysulfid content of the combination spray that had been treated with lime had decreased only a negligible amount while the untreated showed a loss of almost 50 per cent of its fungicidal and insecticidal properties.

Attention is further called to chemical changes that had continued during two days: Where lime had been previously added to the combination spray over 75 per cent of the lime sulfur remained unchanged and as efficient as ever for spraying purposes. Where no lime had been added all polysulfid sulfur had been transformed into sulfid of lead or to thiosulfate. In this form the spray is practically valueless as its peculiar properties are destroyed.

Conclusions

The data herein reported indicate that there is a pronounced detrimental chemical reaction between lime sulfur and lead hydrogen arsenate when mixed for a combination spray.

The addition of lime at the rate of about ten pounds to 100 gallons of lime sulfur, previous to adding the lead arsenate, prevents to a certain extent this reaction.

THE HOUGHTON GOOSEBERRY APHIS

By A. C. Baker, *Entomologist, Deciduous Fruit Insect Investigations, U. S. Bureau of Entomology*

In 1906 James Troop[1] described under the name of *Aphis houghtonensis* a species of aphid injurious to gooseberries in Indianapolis. Troop's specimens were taken during 1904 and later during 1905. Specimens were sent to Washington and were mounted and studied by Mr. Pergande. The first sending was received on July 25, 1904. On this material Pergande made the following note: "The apterous females are pale dirty yellowish, the abdomen marked with very few dark or bluish-green, scattered spots; the eyes dark brown; the antennæ yellowish with apex of the 5th, the 6th and the spur dusky; nec-

[1] Ent. News Phila., Vol. 17, p. 59–60.

taries and tail of color of body; no lateral tubercles on body; hairs of antennæ, head, body and legs capitate; nectaries rather short."

Other sendings were received from Troop and recorded by Pergande on the following dates: August 1, 1904, August 25, 1904, October 6, 1904, May 15, 1905, and May 22, 1905. Under this last date Pergande made some color notes on the live alate form as follows: "The abdomen of the migrant is of a light glassy, bluish-green color, the head and thorax brownish-yellow with the thoracic lobes somewhat darker."

Three other records of the species have been made. Davis[1] (1910) recorded the species from Illinois and figured the sensory characters of the alate form, while Davidson[2] (1914) recorded the species doubtfully from California. These two workers have since written that the insects described by them were not this species. The third record is that of Headlee[3] (1916).

On May 12, 1916, Mr. F. L. Simanton reported an aphis injurious to the Houghton gooseberries at Benton Harbor, Mich. Specimens of this species were submitted on May 22nd and proved to be *houghtonensis*. Mr. Ackerman forwarded young stem mothers from this same locality in the spring of 1917 and from these young rearing experiments were begun.

Eggs

The specimens received were upon small infested shoots and indicated that the eggs, the shells of which were present, are laid upon the bark under the loose folds which extend down the twig. Later twigs were received with many eggs still unhatched and these showed that the usual position is under the loose bark though eggs are also laid about the bases of the buds and occasionally upon the thorns. The eggs hatch about the middle of April.

Stem Mother

As soon as the young stem mothers are hatched they wander to the young opening leaves to feed and place themselves either on the under surface of the leaves or upon the petioles. The leaves immediately begin to curl and before long entirely enclose the stem mothers and any young they may have produced. In our experiments a young stem mother which began feeding on a leaf May 1 was by the 10th entirely enclosed by the rolled up leaf. By this time she had produced several young but only one remained on the curled leaf with her, the others migrating to new leaves.

[1] Jr. Econ. Ent., Vol. III, p. 485.

[2] Jr. Econ. Ent., Vol. VII, p. 132.

[3] Rept. of the Entomologist of New Jersey for 1915.

Alate viviparous Form

It is interesting to note that this form occurred in every generation in which specimens were reared from the second onward. Part of the offspring of the stem mothers thus became winged. All specimens of this form which were placed upon gooseberry in the experiments died without reproducing and this would seem to indicate that an alternate host is necessary, at least to certain individuals.

Description

Fifth Instar (adult).—Color dark green, head and thorax brownish; eyes dark brown. Antennæ, distal part of femora and tibiæ and the tarsi brownish. Wing veins margined with brown. Cornicles pale.

Length from vertex to tip of cauda 1.44 mm. Forewing 3.2 mm. long, 0.88 mm. broad at the stigma. Length of the antennal segments and cornicles is given in the following table. There is considerable variation in the size of the specimens and the number of sensoria and this is indicated by the variations in the table. Vertex and antennal segments armed with a number of capitate hairs; similar ones also present on the legs and abdomen, and a few upon the thorax. Cornicles flanged and distinctly imbricated, slightly swollen in their distal portion. Cauda constricted near base, minutelyse tose and armed usually with five prominent hairs. Slight antennal tubercles are present on the head.

Table of Measurements of the Antennæ of the Alate Form

Seg. III	No. of sen.	Seg. IV	No. of sen.	Seg. V	No. of sen.	Seg. VI base	Seg. VI unguis	
0.384	23	0.176	7	0.16	4	0.064	0.416	0.192
0.384	24	0.176	4	0.16	4	0.064	0.432	0.192
0.4	20	0.224	5	0.224	2	0.08	0.512	0.224
0.4	22	0.24	6	0.224	1	0.08	0.496	0.24
0.464	23	0.224	2	0.224	1	0.08	0.624	0.192
0.448	22	0.272	3	0.256	3	0.08	0.608	0.192
0.48	19	0.288	5	0.272	2	0.096	0.672	0.192
0.448	21	0.256	6	0.272	2	0.08	0.608	0.208
0.48	17	0.288	5	0.272	1	0.096	0.565	0.192
0.480	27	0.272	6	0.256	1	0.08	0.56	0.208

Intermediate

One intermediate was available for study. This was taken in the field by Mr. Simanton. We are unable to give, therefore, anything in regard to its occurrence or reproductive activities.

Description

Color similar to that of the apterous form. Length from vertex to tip of cauda 1.296 mm. Width, 0.688 mm. Form flat with the thorax broad giving a shoulder effect not found in the apterous form but apparently without distinct wing rudiments. Antennæ as follows: Segment III, 0.384 mm. and armed with 15 sensoria; IV, 0.208 mm. and without sensoria; V, 0.208 mm. and with only the distal sensorium; VI (0.08 mm.+0.432 mm.). Cornicle, 0.224 mm. Cauda, 0.192 mm. Beak extending beyond the second pair of coxæ. Body armed with the usual hairs.

Summer Apterous Form

This form first appeared in our experiments on May 9th when young were produced by adult stem mothers. They attacked the leaves in the same manner as did the stem mothers and caused many of them to roll very tightly so that great difficulty was experienced in examining the insects. These forms also fed on the tender growing shoots and produced the beginnings even in the second generation of that distortion so conspicuous in the field.

Description

First Instar.—General color uniform pale greenish due to the body contents. The skins are transparent with the exception of the tarsi, the tips of the distal segments of the antennæ and the tip of the labium. Antennæ of four segments with the following measurements: Segments I and II about 0.032 mm. long and about as thick as long; segment III, 0.096 mm.; segment IV (0.032+0.096 mm.). Segment III is armed with two stout spines near the distal sensorium and segment IV has one or two similar ones. The unguis is imbricated. Labium about as long as the antennæ.

Second Instar.—Very similar in general appearance to the insects of the last instar. The antennæ, however, possibly show a little more dusky than those of the previous stage. Measurements as follows: Segment I, 0.048 mm. long and nearly as wide; segment II, 0.032 mm. long and of about the same width; segment III, 0.16 mm.; IV (0.048+0.16 mm.). Segment III with a number of stiff hairs, similar hairs rather prominent also on the first two segments. Cornicles very short and broad.

Third Instar.—General appearance very similar to that of the last instar. Measurements as follows: Antennal segment I, 0.64 mm. long; segment II, 0.048 mm.; segment III, 0.192 mm.; segment IV, 0.096 mm.; segment V (0.048+0.224 mm.). The segments are armed in a manner similar to those of the last instar. In some cases segment III is divided.

Fourth Instar.—Color as in previous instars. Measurements as follows: Antennal segment III, 0.16 mm.; segment IV, 0.096 mm.; segment V, 0.096 mm.; segment VI (0.048+0.256 mm.). Segments armed with hairs which are somewhat stouter than in the previous instars. Otherwise individuals of this instar resemble those of the previous instar.

Fifth Instar (adult).—Color yellowish-green maculated with a darker green upon the abdomen, eyes brown. Sixth segment of antennæ and the distal extremities of V, IV, and III dusky, cauda and cornicles concolorous with the abdomen.

Length from vertex to tip of cauda 1.44 mm., width across abdomen 0.768 mm. Antennæ as follows: Segment III, 0.384 mm., armed with about ten subcircular sensoria in a row on the basal three-fourths of the segment, 12–14 capitate hairs also present; IV, 0.224 mm., without sensoria but with 4 or 5 capitate hairs; V, 0.208 mm., with a very prominent distal sensorium and several capitate hairs; VI (0.08 +0.43 mm.), imbricated and armed with hairs on the base. Vertex with a median projection and armed with capitate hairs which are also present on the slight antennal tubercles. Body covered with similar hairs. Cornicles 0.224 mm., imbricated, almost cylindrical, not swollen as much as in the alate form. Cauda similar to that of the alate form but somewhat broader.

Sexes

The sexes which have not before been described appear upon the bushes in September and October and eggs are laid (in confinement) as early as the first week in October. Both sexes are apterous, the males being very small. Descriptions of the sexes follow:

Male

Fifth Instar (adult).—In general color the male does not differ greatly from the other apterous forms though it is darker, the antennæ being quite dusky. Average measurements are as follows: Antennal segment I, 0.064 mm.; II, 0.048 mm.; III, 0.256 mm.; IV, 0.16 mm.; V, 0.144 mm.; VI (0.048+0.256 mm.). The segments are armed with short, rather stout hairs and with small circular sensoria. These last number about as follows: Segment III with 14 or 15 of uneven size and irregularly placed over the segment, IV with usually 6, V with about 5. In some cases segments III and IV are united and measure about 0.356 mm. and possess about 22 irregularly placed sensoria. Cornicles short, not more than 0.096 mm., subcylindrical, slightly swollen near their distal extremities. Hind tibiæ about 0.624 mm. Cauda 0.096 mm. Length from vertex to tip of cauda 0.96 mm.

Ovipara

Fifth Instar (adult).—General color very similar to that of the viviparous form, the one or two large eggs within showing very distinctly through the abdominal wall. Average measurements as follows: Antennal segment III, 0.176 mm.; IV, 0.112 mm.; V, 0.112 mm.; VI (0.064+0.272 mm.). The antennæ are without secondary sensoria but the segments are armed with short rather stout spine-like hairs. Cornicles 0.144 mm., almost cylindrical, distinctly imbricated, possessing, however, quite a marked flange and a considerable constriction just proximad of it which gives the cornicle the appearance of being slightly swollen. Cauda about 0.128 mm. Hind tibia not distinctly swollen but armed with a small group of sensoria on its proximal quarter, length of tibia 0.544 mm. Length from vertex to tip of cauda about 1 mm.

THE LIFE HISTORY AND EARLY STAGES OF MACROPSIS VIRESCENS VAR. GRAMINEA (FABR.),[1] A POPLAR LEAF HOPPER IN NEW JERSEY (HOM.)

By Harry B. Weiss and Edgar L. Dickerson, *New Brunswick, N. J.*

The following notes are the results of observations made at various times during the past several years on *Macropsis virescens* var. *graminea* which was fairly abundant on Lombardy poplars growing in a nursery at Irvington, N. J.

The species overwinters in the egg stage, the eggs being found in two year old wood, usually in the neighborhood of the buds near the end of the growth, although some eggs were found in the twig tissue between the sets of buds. The eggs are inserted singly on their sides just beneath the bark tissue and the bark over the egg is raised showing

[1] Identified by E. P. Van Duzee.

the contour in a somewhat irregular fashion. The tissue around the egg is somewhat discolored and brownish but there is practically no cracking of the bark over the egg. There is, however, a slight crack in the bark where the egg is inserted. The eggs were found in all positions and aside from the fact that each egg is inserted resting on its side, there appears to be no uniformity in deposition.

Hatching takes place during the first week in May at a time when the leaves are small and by the last few days in May and the first part of June, the first adults appear. The bulk of the adults, however, appears about the middle of June and from then on until the middle of July and later they can be found scattered over the trees. Egg laying takes place during the last of June and first part of July. Females collected on July 2 and dissected were found to contain 8, 7, 3, 8 and 2 eggs each.

There are five nymphal stages and the combined time necessary for them to mature is about one month. The early stages are found on the young unfolding leaves and leaf petioles, usually at the bases with their heads downward although some can be noted in the reverse position, sometimes three or four on a single leaf. As they become older they disperse and move to the stems where they rest in similar positions in the axils of the leaves or occasionally on the petioles.

Practically all of the nymphal feeding takes place at such localities and only rarely are the nymphs found on the leaves. Resting on the stems as they do, they closely resemble buds. The cast skins are found fastened securely by the beaks to the petioles and occasionally on the upper and lower leaf surfaces, indicating where moulting takes place. As a rule the nymphs are more or less sluggish and can be captured readily. The adults are more active especially on bright, sunny days but they also have the habit of resting mostly on the twigs.

Egg.—Length, 1.1 mm.; greatest width, 0.19 mm. Translucent, subcylindrical, elongate, curved, tapering to both ends which are rounded, basal end more broadly rounded than apical end.

First Nymphal Stage.—Length, 1.2 mm.; width of head, including eyes, 0.35 mm. Elongate-elliptical; tapering gradually to posterior end; front subtruncate or broadly rounded; dorsal surface sloping upward from lateral margin and forming a median ridge. Light brown on dorsal and lateral surfaces; dorsal surface of this and remaining stages specked with black; legs light brown except at coxal-femur joint. Eyes lateral, prominent, consisting of a number of ommatidia. Antennæ extending beyond posterior margin of prothorax, two basal segments quadrate, subequal, apical segment two and one-half to three times as long as basal segments combined, tapering gradually to tip. A pair of minute spines on top and vertex of head and several spines below on front and base of rostrum; all of these spines anteriorly directed. Two minute, median pairs of spines on prothorax, one anteriorly and the other posteriorly directed (one pair behind the other); on remaining thoracic segments, a pair of posteriorly directed, median, dorsal, slightly curved spines with united base.

Each abdominal segment bears a pair of posteriorly directed, median, dorsal spines with united base. Minute, posteriorly directed spine arising from lateral margin of each abdominal segment; one or more longitudinal rows of fine spines on abdomen between median-dorsal and lateral rows; few, minute spine-like hairs on posterior end. Tibia and tarsus bear number of minute, spine-like hairs. Ventral surface light; rostrum extending to beyond bases of second pair of legs.

Second Nymphal Stage.—Length, 1.6 mm.; width of head, including eyes, 0.5 mm. Somewhat similar to preceding stage in color, shape and armature. Shape slightly broader. Color light brown with darker bands extending longitudinally from anterior to posterior end between lateral margin and dorsal ridge. Armature more pronounced, similar to that of preceding stage except for an additional, smaller spine and indications of another on the lateral margins of the abdominal segments anterior to spine noted in first nymphal stage. Ventral surface light; coxa and femur lighter; rostrum similar to that of first stage, lancets on most specimens extending beyond tip of rostrum.

Third Nymphal Stage.—Length, 2.2 mm.; width of head, including eyes, 0.75 mm. Somewhat similar to second stage, slightly broader, especially at posterior part of thorax. Lateral margins of thoracic segments, especially that of mesothorax slightly expanded. Lateral, posterior margins of mesothorax partially cover those of metathorax. Dorsal thoracic surface tending to become rounded. Abdominal segments maintaining median ridge, especially in posterior portion where it is quite acute. Color darker, broad bands noted in preceding stage prominent in some specimens and in others so suffused as to leave lighter shade along median, dorsal ridge. Eyes lateral, globular, prominent. Armature somewhat similar to that of preceding stage, all spines more prominent; hair-like spines on legs more prominent; spines on outer surface of tibia forming rows along anterior and posterior margins. Ventral surface light; legs similar in color to brown of dorsal surface; rostrum similar to that of preceding stage.

Fourth Nymphal Stage.—Length, 3.2 mm.; width of head, including eyes, 0.89 mm. Similar in color and shape to that of third stage except for the head which is shorter, being four to five times as broad as long. Spines on head less prominent. Sides of meso- and metathorax extending posteriorly so that lateral lobes of mesothorax cover much of metathoracic lobes which extend into the second abdominal segment and partially cover sides. Several spines on lateral margin of mesothoracic lobes. Minute spines along lateral margin of abdomen increasing in number. Median ridge decidedly acute on abdomen, more so toward posterior end. Otherwise similar to third stage nymph.

Fifth Nymphal Stage.—Length, 4.2 mm.; width of head, including eyes, 1.3 mm. Elongate-elliptical. Head, dorsal surface of thorax and abdomen, tibia and tarsus reddish-brown (some specimens lighter with two longitudinal bands prominent); posterior parts of body darker in some specimens. Eyes more prominent, antennæ similar to those of preceding stages. Wing pads of mesothorax extend posteriorly and cover outer portion of those of metathorax. Both pairs extend to lateral margin of second abdominal segment. Dorsal median ridge prominent and darker on top. Armature similar to that of preceding stage, dorsal, median spines less prominent. Number of minute spinelike points on ventral surface. Rostrum similar to that of fourth stage. Circle of hairs bordering anal opening. Sexes distinguishable in this stage. Otherwise similar to preceding stage.

Adult.—*Macropsis virescens* var. *graminea* Fabr. The following is the original description from Ent. Syst. Suppl., 1798, p. 521. "Cicada graminea. viridis capite

subeleuto: puncto apicis atro. Habitat in Italia Dr. Allioni. Statura omnino C. prasinæ at paullo minor et distincta. Corpus totum viride puncto solo atro in apice capitis postice parum eleuati."

The following brief description of this species is given by Osborn (Bul. 238, Me. Agric. Exp. Sta., 1915): "Approaching *viridis* but smaller and more slender with a conspicuous black spot on the base of the hind tibia. Female, length, 5 mm.; width, 1.25 mm. Male, length, 4.4 mm.; width, 1 mm. Vertex very short, strongly angled, rounded at extreme tip; pronotum sharply angled in front, sloping to front and sides, concave behind or with hind border subangularly excavated. Color of female light green, elytra becoming transparent toward tip; eyes brown; a black spot at base of tibia; tarsi yellowish-brown; male slightly darker than female, the elytra in one specimen faintly, in the other distinctly smoky; scutellum with a black triangle in lateral angles, eyes and tarsi as in female and the black spot on base of hind tibia distinct." He further states that "this species is apparently identical with the European form and has been recorded for America but once in my report (20th N. Y.). The New York specimens were referred to the variety *graminea* in which there is a black spot at tip of vertex."

So far there are only two recorded localities for this species in America. Osborn (20th Rept. State Ent. N. Y., 1904, p. 505) states, "two specimens, females collected on willow at Fitch Point, near the Fitch Home, Salem, N. Y., August 14, 1904." In the Maine bulletin he records "three specimens were taken in sweeping on a clump of cornus July 22 near Orono on Dr. Patch's farm. No nymphs were taken and it is unsafe to regard cornus as food plant as there were willows in vicinity."

Our material was found abundantly on Lombardy poplar in a nursery at Irvington (near Newark), N. J. Specimens of what was apparently this species were also found on elm in a nursery at Rutherford, N. J. There seems little doubt that this is as suggested by Osborn, a European species. Its introduction could readily be accounted for by the fact that the insect overwinters in the egg stage in the twigs.

Van Duzee in his catalogue of Hemiptera gives the following references:

Fabricius, Ent. Syst. Suppl., p. 521, 1798 *Cicada*.
Fabricius, Syst. Rhyng., p. 77, 1803 *Cicada*.
Germar, Mag. d. Ent., IV, p. 81, 1821 *Jassus*.
Fieber, Verh. Zool. Bot. Ger. Wien., XVIII, p. 459, 1868 *Pediopsis*.
Oshanin, Vers. Palae. Hemip., II, p. 73, 1906 *Pediopsis*.
Osborn, 20th Rept. N. Y. St. Ent., p. 505, 1905 *Pediopsis*.
Horvath, Ann. Mus. Natl. Hung., VI, p. 6, 1908 *Pediopsis*.
Osborn, Me. Agr. Exp. Sta. Bul. 238, p. 90, 1915 *Pediopsis*.
Localities, N. Y., Me., Europe.

LACE BUG ON HAWTHORN, CORYTHUCHA BELLULA GIBSON[1]

(TINGIDIDÆ, HEMIPTERA)

By WALTER H. WELLHOUSE, *Ithaca, N. Y.*

This tingid was originally found June 18, 1917, four miles southeast of Tiffin, Ohio, on four or five Cratægus trees by Carl J. Drake and the adult was described March, 1918, by E. H. Gibson (Trans. Amer. Ent. Soc. 44: 69–104). Professor Drake informs the writer that he found one of these trees very badly infested with thousands of specimens feeding on it and that he found eggs, nymphs and adults on this same tree in August, 1918. There is no other record of this species having been found. The writer has observed it during the past year in several localities about Ithaca.

HOSTS

It seems to confine its attack to those species of Cratægus that have an abundance of pubescence along the veins on the lower sides of the leaves. I have found it breeding in abundance on *Cratægus neofluvialis* and to some extent on *C. albicans* and *C. punctata.* Those species with smooth leaves, such as *C. pruinosa*, *C. crus-galli* and *C. oxyacantha*, even when their branches were intermingled with those of trees which were badly infested, revealed no nymphs or eggs.

INJURY

In a large thicket of *Cratægus neofluvialis* trees near the Cornell University campus the leaves were so discolored by the end of July that they attracted the attention several hundred yards away. By the middle of August the leaves were falling and the branches were bare by September 1. No fruit matured on these trees. A few scattered trees of this species in other directions from the city were also badly infested. Individual trees of *Cratægus albicans* and *C. punctata* showed an occasional branch badly infested and with leaves discolored. The injury is caused by the nymphs and adults puncturing the undersurface of the leaf and sucking the sap, thus causing at first a mottled effect due to the pale areas around the feeding punctures, while later the leaf turns brown and falls to the ground. Ornamental plantings of Cratægus in parks and gardens may be rendered unsightly and weakened by this injury.

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[1] Contribution from the entomological laboratory, Cornell University, Ithaca, N. Y.

Life History

There are two generations of the insects a year at Ithaca. The first brood hatches in July from eggs laid in late May and June, and the nymphs become mature in from 20 to 25 days after hatching. The second brood eggs are laid in late July and August and the adults appear in late August and September.

Hibernation.—The adults of the second brood hibernate among the fallen leaves and in crevices of the bark. Many of them remain on the leaves upon which they were feeding before the leaves fell. They appeared the last of May and during early June at Ithaca in 1918 were feeding on the new Cratægus leaves. As a rule only one pair of adults was found on a leaf and they remained feeding and ovipositing on that same leaf for several days. After emergence from the nymphal skin in September, the adults of the second brood continue feeding on the leaves until the latter fall, in late September or October. The insects were feeding last fall after two heavy frosts.

Egg.—The egg is subelliptical in shape, with the basal end rounded, and the apical end bent slightly to one side and capped with a rather broad cylindrical collar surmounted by a low cone with irregular ridges extending from base to apex. From the apex of this cone there sometimes arises a short blunt prolongation but often this is absent. The egg is without waxy covering over the chorion which is smooth, and unsculptured, and of a shining dark-brown color but somewhat lighter toward the base. The cap or cone is often whitish. The egg exclusive of the apical prolongation of the cap is 0.52 mm. long and 0.21 mm. broad at its greatest width.

The eggs are laid on the under surface of the leaf in the axils formed by the midrib and its lateral branches. Although the female has a well developed, saw-like, four-valved ovipositor, the eggs are not inserted into the leaf tissue. They are placed among the hairs on the veins and are sometimes glued together with an adhesive material. They are generally laid in small groups, some groups containing as many as 18 or 20 eggs and occasionally the eggs are laid singly. In counting the number of eggs on 100 infested leaves I found an average of 49 eggs per leaf. Occasionally a leaf had 75 or 80 eggs on it. The egg-laying period extends over several weeks so that eggs, nymphs and adults may be found at the same time in July and August.

Eggs laid June 2 hatched on July 9 and 10 while the eggs of the second brood, laid July 29 and 30, hatched August 15 and 16. This indicates an incubation period of about 37 days in the cooler temperature of June and 18 days in July and August when the average temperature was higher.

The conical egg cap is pushed up by the nymph as it begins to emerge

from the egg still enclosed in the embryonic membranous sac. When about half way out of the egg shell the nymph splits the membranous sac and slips it off over the head, leaving it with the egg cap on the outer end hanging out from the empty egg shell.

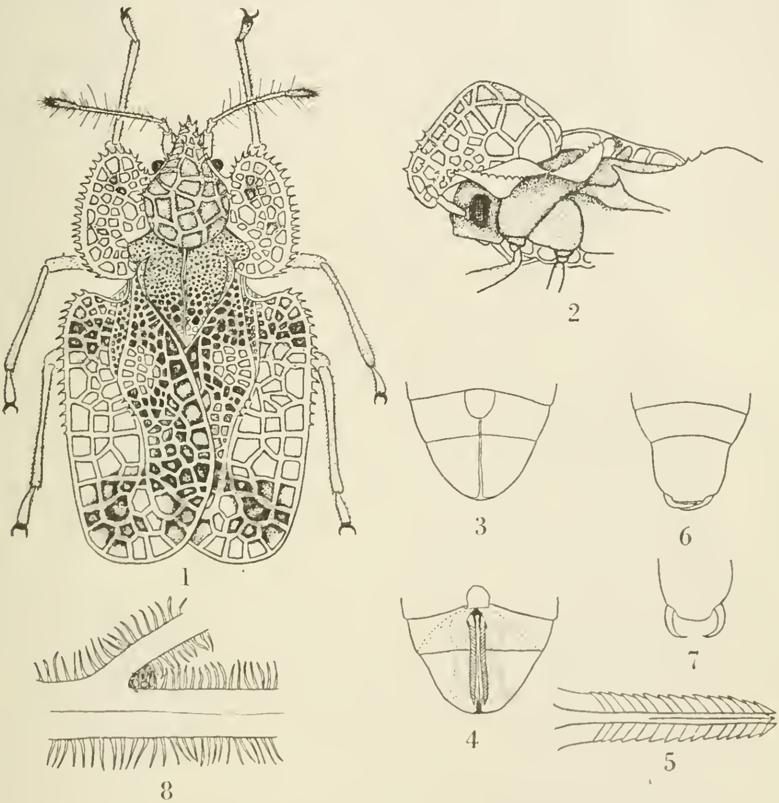

Fig. 24.—1, Adult *Corythucha bellula* Gib.; 2, lateral view of hood and carina; 3, tip of abdomen, ovipositor at rest; 4, same, ovipositor exserted, chitinized tendons within body shown by dotted lines; 5, ovipositor; 6, tip of abdomen of male, claspers at rest; 7, same, claspers exserted; 8, eggs in position among hairs in axil of veins.

Nymphs.—After emerging and drying the nymphs begin feeding at once in colonies near the egg shells. They molt five times, feeding from three to six days between molts, the earlier stages requiring three or four days while the later ones require five or six days. In molting the cuticula breaks along the median dorsal line from the front of the head to about the second abdominal segment. The insect on emerging is limp and almost colorless except the eye facets which are bright red. The body color soon darkens and the eyes a few hours later become

black. During the fifth stage the nymphs wander about more freely over the leaf and sometimes go to adjoining leaves.

Description of Nymphal Stages

First Stage.—Length, 0.5 mm.; greatest width, 0.15 mm. General shape an elongate ellipse somewhat broader cephalad than caudad and more elongate than the later stages. At first almost colorless but soon becoming dark brown. Beak 4-segmented and extending back to the sixth abdominal segment. Antenna 3-segmented, the basal two segments being shorter than the third segment. The basal segment is without spines or hairs, the second segment has a few short hairs, the third segment has numerous long spines and hairs; some with rounded tip and conical base, others with pointed tip. Head with five prominent dorsal tubercles, two slightly separated just above the base of the beak, each bearing a round-tipped spine; one tubercle back of these on the median line bearing two spines; two tubercles near the posterior margin widely separated and each bearing two spines. Pro- and mesothorax have lateral tubercles with a spine on each and the mesothorax has a pair of dorsal tubercles with one spine on each. Metathorax and first abdominal segment are without spines. Legs armed with short pointed hairs and two bent sharp terminal claws. There are nine abdominal segments visible above and each of these excepting the first bears a tubercle surmounted by a round-tipped spine, on both lateral margins of the segment. Two dorsal tubercles are on the second, fifth, sixth, and eighth abdominal segments; those on the second and eighth bearing one round-tipped spine each, and those on the fifth and sixth bearing two spines each. The tenth abdominal segment may be seen from a lateral or ventral view and this segment bears no spines or hairs. Minute awl-shaped spinules occur over the dorsal surface, especially on the large tubercles of the fifth and sixth abdominal segments and on the thorax.

Second Stage.—Length, 0.68 mm.; greatest width, 0.27 mm. The body broader in proportion to its length than in the first stage. Dark brown in color with numerous minute spinules over the dorsal surface covering it much more completely than before. Additional small spines have appeared on both dorsal and lateral tubercles and the round-tipped spines present before have a slightly longer conical base now.

Third Stage.—Length, 0.82 mm.; greatest width, 0.44 mm. The antenna has four segments now. The round-tipped spines arise from a base longer than the spines and a few small spines have appeared on the tubercles. The pro- and mesothorax are beginning to increase in prominence.

Fourth Stage.—Length, 1.2 mm.; greatest width, 0.7 mm. The wing pads of the mesothorax extend back over the metathorax and first abdominal segment at the sides. The prothorax is more prominent than before. Bases of the round-tipped spines are several times as long as the spines. A few new spines are present on the lateral margins of the pro- and mesothorax and of the abdomen. The color is dark-brown except in an irregular band across the abdomen just caudad of the wing pads and on the lateral thirds of the prothorax where the color is yellowish. The minute spinules cover the entire dorsum, being light colored on the yellowish portions and dark on the brown portions. These spinules are also present on the bases of the round-tipped spines.

Fifth Stage.—Length, 1.6 mm.; greatest width, 0.96 mm. The wing pads now extend back to the fourth abdominal segment at the sides and the prothorax is still more prominent. A few more spines have appeared on the tubercles and many of the sharp pointed spines have become round-tipped. Spines on the lateral margins of those segments covered by the wing pads have disappeared. The yellowish parts

of the prothorax have increased in size and the distal part of the wing pads is yellowish, so the body appears to have two light bands across it. The entire dorsal surface is covered with minute spinules as before.

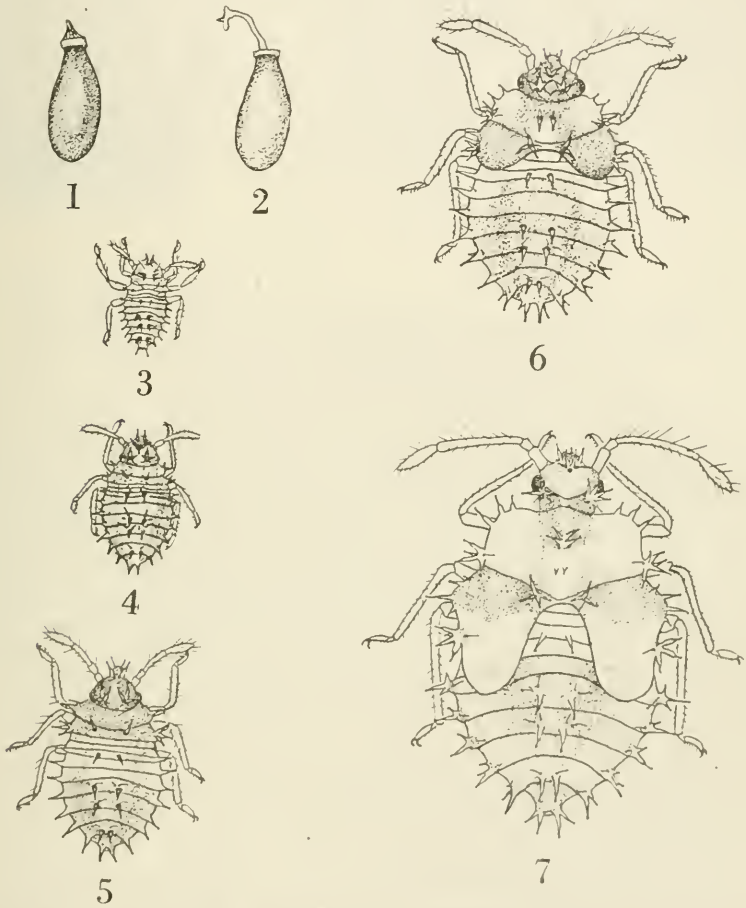

Fig. 25.—1, Egg; 2, egg after hatching; 3, first stage nymph; 4, second stage nymph; 5, third stage nymph; 6, fourth stage nymph; 7, fifth stage nymph.

The larger spines in all the stages of the nymphs correspond exactly in position and appearance with those described by Morrill for the oak tingid, *Corythucha arcuata* (Psyche 10: 128), but in *Corythucha bellula* the minute awl-shaped spinules are more prevalent on the dorsal surface and the nymphs are smaller than *C. arcuata* nymphs. The spines borne on elongated bases have an eversible sac on the tip which gives them a trumpet shape when it is drawn in and a round tip when it is extended.

Control

Many of the last stage nymphs of the second brood were preyed upon by the immature stages of several spiders which spun webs over the leaves. The adults which survive the winter are comparatively few so that the first brood does little injury. In case the second brood nymphs should become too numerous on ornamental plantings they may be controlled by using one of the nicotine sprays commonly used against leaf bugs on apple. The sprays must be directed upward to cover the undersides of the leaves.

THE FUNCTION OF THE ANAL COMB OF CERTAIN LEPIDOPTEROUS LARVÆ

By S. W. Frost, *State College Research Laboratory, Arendtsville, Pa.*

Lepidopterous workers are aware that certain larvæ possess a comb-like structure on the ventral aspect of the last abdominal segment. Heretofore this comb has served simply as a convenient systematic character for separating closely allied larvæ such as *Laspeyresia molesta* Busck and *Laspeyresia prunivora* Walsh from *Laspeyresia pomonella* Clem. The writer has discovered a more interesting and, from the standpoint of the larva, a more useful function of the anal comb. While examining a larva of *Sparganothis indœusalis* Walk., a pellet of frass was tossed with considerable force against the wall of the container in which the larva was kept. Upon further examination the use of the anal comb was revealed. The frass flows out from the posterior end of the alimentary canal in a small pellet. The anal comb is then bent downward until it touches the frass and with a sudden snap backwards it tosses the pellet away from the body.

This interesting performance led to the examination of several other larvæ, both with and without the anal comb, with the idea of determining if any correlation exists between the habits of the larva and the possession of the anal comb. Fourteen larvæ were available for the examination, all feeders of apple and representing various larval habits as: Case bearers, leaf miners, borers, and external feeders.

The case bearers, leaf miners and borers possess no anal comb and an examination of their habits explains the uselessness of such a structure. For example, *Mineola indiginella* Zellar and *Tmetocera ocellana* Schiff., construct trumpet-like cases from which they feed. The frass is removed from the interior of their cases by means of their mandibles and placed on the exterior of their cases. A comb would be of no

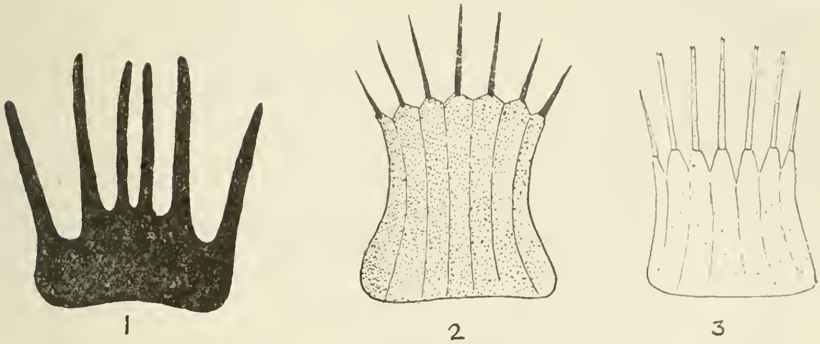

Fig. 26.—1, *Laspeyresia molesta* Busck; 2, *Sparganothis indaeusalis* Walk.; 3, *Archips rosaceana* Harris.

advantage to these larvæ but on the contrary would be a decided disadvantage because it would toss the frass beyond their reach. Again, *Laspeyresia pomonella* Clem., is strictly a boring insect, working within the fruit. As might be supposed an anal comb would be of no use to a larva in a burrow of this sort. The larva pushes its frass from its burrow and has no need of a comb. Finally three other larvæ were examined representing the leaf-mining habit namely, *Tischeria malifoliella* Clem., *Lithocolletes blancardella* Fab., and *Ornix geminatella* Packard. Here again the anal comb would be of no use to the larvæ because they are confined between the epidermal layers of the leaves and the frass could not be tossed away from the body.

On the other hand the larvæ, feeding externally on the leaves or fruit or more or less protected by curled or dried leaves, do not show any definite correlation between the habits of the larvæ and the possession of the anal comb. For example, *Stenoma algidella* Walk., and *Graphiphora alia* (Authors) possess no anal comb while other larvæ as *Sparganothis indausalis* Walk., *Eulia velutinana* Walk., *Archips rosaceana* Harris, *Ancylis nubeculana* Clem., *Peronea* sp., and *Laspeyresia prunivora* Walsh, have a distinct anal comb.

It is evident that in some cases, at least, a definite correlation exists but the writer does not intend this article to be conclusive as but a very small number of larvæ are considered. Some one with a long series of larvæ available may find the correlation even more interesting.

INSECTS ATTACKING SUGAR CANE IN THE UNITED STATES

By T. E. Holloway and U. C. Loftin, *Bureau of Entomology, U. S. Department of Agriculture*

Following the general plans of Mr. D. L. Van Dine (1) in Porto Rico and Mr. G. E. Bodkin (2) in British Guiana, the writers have compiled the following list of sugar cane insects of the United States. Thanks are due the various specialists for determinations, and acknowledgment is made to Mr. E. R. Barber and Mr. George N. Wolcott for several species collected by them.

1. *Diatræa saccharalis crambidoides* Grote.

Determined by H. G. Dyar.

Common names: The borer, the sugar cane borer, the sugar cane moth borer.

Parasites:

Native: The egg parasite, *Trichogramma minutum* Riley.

Determined by A. A. Girault. Very common.

The egg parasite, *Ufens niger* Ashmead. Determined by A. A. Girault. Reared once from eggs collected near Brownsville, Tex. Apparently rare as a parasite of *Diatræa.*

Introduced: A tachinid fly, *Euzenilliopsis diatrææ* Towns.

Determined by C. H. T. Townsend and described (3) by him as new. Introduced by the writers from Cuba in 1915. Though it attacked the sugar cane moth borer in Louisiana, it has apparently since died out. Further introductions are being made.

Remarks: The sugar cane moth borer is by far the most injurious insect to sugar cane in the United States. Though it attacks corn, it should not be confused with the corn stalk borer, *Diatræa zeacolella* Dyar, which has a different geographical distribution (4, 7), and only rarely attacks sugar cane.

2. *Diatræa lineolata* Walker.

Determined by H. G. Dyar.

Parasite: A braconid reared by Dr. A. W. Morrill at Phoenix, Ariz.

Remarks: This borer, similar to *D. saccharalis,* has the distinctive habit of feeding on the leaves until quite large. It has been observed at and near Phoenix, Ariz., on sugar cane and Johnson grass by the authors.

3. *Pseudococcus calceolariæ* Mask.

Determined by E. E. Green.

Common names: The sugar cane mealybug, *pou-a-pouche.*

Parasites: Several hymenopterous parasites not yet determined.

Predator: The ladybeetle, *Crytolæmus montrouzieri,* has been introduced several times, but has not become established.

Associates: The Argentine ant, *Iridomyrmex humilis* Mayr, and other ants.

Remarks: Common in restricted districts in southern Louisiana. It would be of much importance if widely distributed.

4. *Pseudoccus calceolariæ minor* Mask.

Determined by E. E. Green.

Remarks: Only a few specimens collected on sugar cane near Orlando, Fla., in 1913.

5. *Ligyrus rugiceps* Lec.

   Common name: The sugar cane beetle.

   Remarks: Occasionally injurious to young corn and sugar cane plants in restricted districts. Later in the season, however, little or no injury which can be attributed to this species can be found in cane fields where there was much injury in the spring, the cane plants sending out "suckers" to replace the dead plants.

6. *Lachnosterna antennata, L. burmeisteri, L. crassissima, L. congrua, Cycocephala villosa* Burm., *Dyscinctus trachypygus* Burm.

   Determined by J. J. Davis.

   Common names: (larvæ) white grubs. (Adults) May beetles, June bugs.

   Remarks: Not noticeably injurious owing to small numbers.

7. *Sphenophorus cariosus* Oliv.

   Determined by W. Dwight Pierce.

   Remarks: Only one specimen of this large weevil was found in a young sugar cane plant near Houma, La., in 1916. This species would undoubtedly be very injurious if it were common.

8. *Limnobaris sp.*

   Determined by W. Dwight Pierce.

   Remarks: This is a small weevil, about the size of a corn weevil. The adults are often seen on the leaves of sugar cane during the summer. The larvæ make small borings in old cane stubble. No known injury can be attributed to this species.

9. *Dræculacephala mollipes* Say.

   Determined by O. Heidemann.

   Common names: The sharp-headed grain leafhopper (6).

   Parasites: The eggs are parasitized by *Abdella acuminata* Ashmead and *Gonatocerus koebelei* Perkins. Determinations by A. A. Girault.

   Remarks: Owing to the very efficient egg parasites, this leafhopper is of no economic importance.

10. *Dræculacephala mollipes minor* Walk.

    Determined by O. Heidemann.

    Parasites: Same as above.

    Remarks: Same as above.

11. *Tomaspis bicincta* Say.

    Determined by O. Heidemann.

    Remarks: This froghopper is rare on sugar cane.

12. *Aphis bituberculata* Wilson.

    Determined by H. F. Wilson and described (5) by him as new.

    Common name: Brown aphis of sugar cane.

    Associate: The Argentine ant (*Iridomyrmex humilis* Mayr.)

    Remarks: This aphis is not common nor injurious.

13. *Sipha flava* Forbes.

    Determined by George N. Wolcott.

    Common name: The yellow sugar cane aphis.

    Remarks: Found on cane in Louisiana only once—at Angola, La.

14. *Leucotermes flavipes* Koller.

Determined by Thomas E. Snyder.

Remarks: This termite has been found damaging planted seed cane. The injury is not common, however.

15. *Frankliniella gossypii* Morgan.

Determined by A. C. Morgan.

Remarks: This thrips is of no economic importance.

16. *Uropoda sp.*, *Tetranychus modestus* Bnks (apparently), *Bryobia pratensis* Garman, *Galumna robusta* Bnks, *Hypoaspis sp.*[1]

Determined by Nathan Banks.

Remarks: These mites are of no economic importance.

17. *Succinea luteola* Gould.[1]

Determined by Paul Bartsch.

Remarks: A snail sometimes common on leaves and stalks of sugar cane in the Lower Rio Grande Valley of Texas. Of no economic importance.

18. *Laphygma frugiperda* S. & A.

Common names: The fall army worm, the southern grass worm.

Remarks: The larvæ of this common moth occasionally feed on the leaves of sugar cane but rarely do much damage.

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[1] Included in this list for convenience.

INVESTIGATION OF CONTROL MEASURES FOR WHITE GRUBS AFFECTING SUGAR CANE IN QUEENSLAND

By J. F. Illingworth, *Gordonvale, near Cairns, North Queensland*

After two years of this investigation I am more and more impressed with the tremendous importance of the problem. Furthermore, I appreciate that any successful methods of control should have a far-reaching importance; for in many sugar-growing countries, as the newer areas are opened up, these insects appear to be on the increase.

Investigation of control measures for white grubs injurious to field crops is as old as Economic Entomology—more than thirty years ago we find that these pests were a serious menace in Europe. When the cockchafer appeared in Denmark in 1887 the government got behind a movement for collecting the beetles by hand, which was carried out so persistently and economically by the people that the country was apparently quickly rid of the pest. Naturally similar methods have formerly been advocated for Queensland, and, in some localities vast quantities of the beetles were collected, at great expense to the growers; but with little apparent result. The only explanation that suggests itself is that areas collected were comparatively small and the price demanded for collecting would bankrupt a state, if all the beetles were collected. These insects are indigenous on the wild grassland, which is very extensive in North Queensland—much more so than the narrow belts of cleared agricultural lands. It appears to me, something like a proposition of picking up all the insects on a square foot, in the middle of a large field, then expecting that this small area would be freed of the pest for succeeding crops. We get the same result—the beetles swarm over it again from the surrounding infested lands, so that no noticeable benefit appears.

Damage Done by Grubs

An estimation of the vast economic importance of this pest in North Queensland is difficult to formulate. First of all, we should consider the immense areas which have gone out of cultivation, solely because of the grubs. On the friable red-volcanic soils, which are of high fertility, this is particularly true. Even much of the land that is now planted to cane will soon go out, unless some relief is furnished. The most distressing part of the situation is that the grubs wait until all the work of planting, chipping and cultivation is finished, and the cane is laid by—all the expense has been put into it—when the grubs begin their devastation. It is heartrending to view the ruin on an estate like Greenhills in the Cairns district, where hundreds of acres of beautiful,

perfect cane goes down to destruction within a few weeks, during March. Once the roots are eaten off, the slightest wind pushes the stools over in that loose soil; then deterioration quickly sets in.

In 1911, a conservative estimate[1] of the annual loss in the Cairns district, through grubs, was 25 to 30 thousand tons; and this loss continued year after year in spite of all efforts to combat the pest. In one year the Cairns growers collected 22 tons of beetles and 9 tons of grubs, at an expense of over £3000; with no apparent diminution in the pest. On this point the following interesting figures[2] will help one to understand what a ton of beetles represent: One pound of beetles equals 250; in one ton there are 560,000 beetles, 60 per cent females equals 336,000 each laying eggs which produce 25 fully grown grubs equals 8,400,000. Since it is estimated that 16,000 grubs are sufficient to destroy one acre of cane; one ton of beetles, therefore, could destroy about 500 acres of cane.

From data at hand, it is easy to see that in all the cane-growing districts of Queensland, the losses from the grub pest alone undoubtedly run into hundreds of thousands of pounds.

Combating the Pest

I must admit that the problem seemed hopeless at first; but I am beginning to see light. In fact, I am more and more encouraged as the investigation proceeds.

Control measures have been developed along several lines, the most important of which are: (1) stimulating vigour in the plant, (2) egg-destruction by cultivation, (3) application of poison, and, (4) removal of feeding-trees.

There are numerous factors which bring about increased vigour, and all of them should be considered as valuable aids in combating the pest, for if the cane is in a thrifty growing condition it will resist the grubs to a considerable degree. Among these factors, I would suggest, the application of lime and fertilizers, supplying humus, and thorough cultivation.

Lime, as every grower knows, improves the physical condition of clay soils, and assists in the rapid change of plant-refuse into humus. It improves the health of soil bacteria and fungi, in other words, which are all-important in the growing of crops. It is well recognized, too, that a leguminous green-crop does very poorly on land without lime, which is essential to the bacteria forming the nitrifying nodules on the roots.

The use of fertilizers is important to the growing of any crop, but

[1] Aust. Sugar Journal, Vol. 3, p. 199.

[2] Aust. Sugar Journal, Vol. 2, p. 443.

this is particularly true with sugar cane, for experiments have demonstrated that a 30-ton crop removes from the soil 102 pounds of nitrogen, 65 pounds of potash and 45 pounds of phosphate. Land poor in these elements naturally produces cane of inferior quality, which easily succumbs to grub injury. Experience has shown, that for best results, small experimental plots should be developed in each locality, or class of soil. In Hawaii this diversified testing is done by the Planters' Experiment Station, with such efficiency that they have found that under certain conditions it pays to apply 1,200 pounds of mixed fertilizers, containing 11 per cent of nitrogen, and on top of this, to add as much as 500 pounds of sulphate of ammonia or nitrate of soda. That is to say, the idea is to apply as much fertilizer as will produce a profit. They also use lime freely. It is by such methods that the output of these small islands has been increased from 75,000 to over 600,000 tons of sugar, in the history of the Station.

Comparatively speaking, little fertilizer is used in Queensland; many of the newer farms get none at all. Consequently, I wish to emphasize not only the value of manures as a factor in grub-control, but further to say that under scientific application they will pay a handsome profit on most soils.

Speaking generally, grubby-soils are lacking in humus. This is true of all of those that I have tested. Experiments have demonstrated that the grubs prefer partly decayed organic matter to living roots. As a matter of fact, they live happily, and develop well in rich soil alone, even when all roots, trash, etc., are removed. Moreover, it is a well-known fact that their bodies are always full of earth during the feeding period; and from this they derive their principal supply of nutriment, by extracting the humus, if present.

Where soils are poor in humus, and all organic matter is removed by the destructive methods of farming now in vogue in Queensland, the grubs are compelled to feed upon the living roots or starve. Furthermore, we know that humus has a remarkable affinity for arsenic, which may be made use of, as I shall point out, later.

What is needed is a method of conserving all trash, and waste from the crop, together with a regular rotation of green-crops. Sooner or later all farms must come under this practice, if the productivity of the land is to be maintained. In line with this advice, I wish to call attention to the large areas at Goondi—the Mundoo section, which produced splendid crops of cane for a few years, but now, is said to be so worn out that it will not pay to work. Apparently many other cane areas are fast approaching this condition, even though only a very few crops have been taken off.

I have emphasized surface cultivation mainly because of its value for

increasing the vigour of the crop, and in this way making the plants more resistant to attack. However, as I shall indicate later, I have found that it often has a more direct action in the destruction of the pest.

Undoubtedly the value of cultivation is recognized; but on many farms it is not carried out. Climatic conditions bring about great difficulties, in this regard, particularly with the late-planted crop. Many soils can not be worked properly when either too wet or too dry, and as a consequence the cane is left to suffer. However, it is common experience that the man who cultivates well is the man who reaps the reward.

I have found by extensive experiments at Greenhills, during the past season, that both the eggs and the young grubs are considerably injured by even shallow cultivation, for they are located near the surface in December. The common cultivators, reaching to a depth of about six inches, are satisfactory for this work; though I got somewhat better results by using a pony-plow, which got in closer to the roots.

In order to be effective this work must start at the time the beetles begin to emerge, and be continued, going over the ground every fortnight while they are on the wing. Normally, this would mean about four cultivations, which would mean no extra work in the case of late cane. I have advocated September-October planting on grubby-soils, where they are well drained, so as to facilitate this cultivation during the flight of the beetles; the plants are then small enough so that the implements can get well under them.

We have had encouraging results in the use of arsenic for the destruction of the grubs. I found that by using arsenious acid (white arsenic) with Greenhill's soil in pots, that full grown grubs were quickly destroyed by ingesting it,—all of them dying in one to four days. The quantity used was approximately what would amount to about 20 pounds per acre. I should state that only sifted soil and arsenic were placed in the pots, so that it was demonstrated that the grubs were destroyed by feeding on the poisoned humus of the soil.

Arsenic was used on our experimental plots at Meringa, in varying proportions and combinations; the best results apparently being from the use of the poison placed in the drill with the plants. In this case 20 pounds was mixed with 5 cwt. of meatworks manure per acre. The cane came along splendidly, with no sign of grub-injury, while several of the other plots showed more or less infestation.

Apparently the most satisfactory and far-reaching remedy, however, is the removal of all feeding trees, within a radius of about half a mile of infested cane areas. Investigation has demonstrated that once

this is done the land becomes immune. This fact is particularly noticeable in the older districts, like the Herbert River and Goondi, where all the land was once more or less infested. Now that the clearing has been far extended, all of the older fields are immune; the only infestation being on the lands laying near the feeding trees. Hence we might justly conclude, that by concerted effort, many of the infested lands could be freed of this pest forever.

Conclusion

As would appear from the above, the outlook is rather encouraging, in spite of the fact that the investigation has been carried on under many difficulties. It has been real pioneering. The spirit of unrest makes it hard to get the backing that a problem of such magnitude requires.

Practical results can only come from extensive application in the field. Already this is started in a small way, but it will take several years of conscientious investigation to bring about conclusive results.

A SUCCESSFUL METHOD OF BREEDING PARASITES OF WHITE GRUBS

By J. F. Illingworth, *Gordonvale, near Cairns, North Queensland*

Since Scarabæid beetles are found probably more abundantly in Australia than in any other part of the world, we naturally find their parasites well developed. Among these parasites numerous wasps have been recorded—about 50 species, according to Froggatt[1] have been described from Australia. I have come in contact with only three of the principal ones, in my investigation of the several species of white grubs that attack sugar cane in North Queensland.

In order to know more definitely the habits of these friendly insects and to try to learn something of the relation of their hyperparasites, I instigated breeding work in the laboratory in 1917, using our two most abundant species (*Campsomeris tasmaniensis* and *C. formosus*).

My assistant, Mr. E. Jarvis, carried out most of the work, since my time was largely occupied in the field. At the time that the breeding was started, in December, the wasps were very numerous, flying over grub-infested lands near our Station. From these I collected several females, and found them very amenable to handling in small cages. When placed in covered tins, holding about half-a-pint of soil, they "dug themselves in" at once. Our usual practice was to place a grub in each of these tins, removing it whenever an egg was found attached

[1] Australian Insects.

to its venter. The wasps were supplied with food by placing small drops of diluted honey on a bit of leaf on the surface of the soil, before covering the tins. When hungry the wasp came up, and though it was dark in the tin, she licked up the nectar and straight way went back to work.

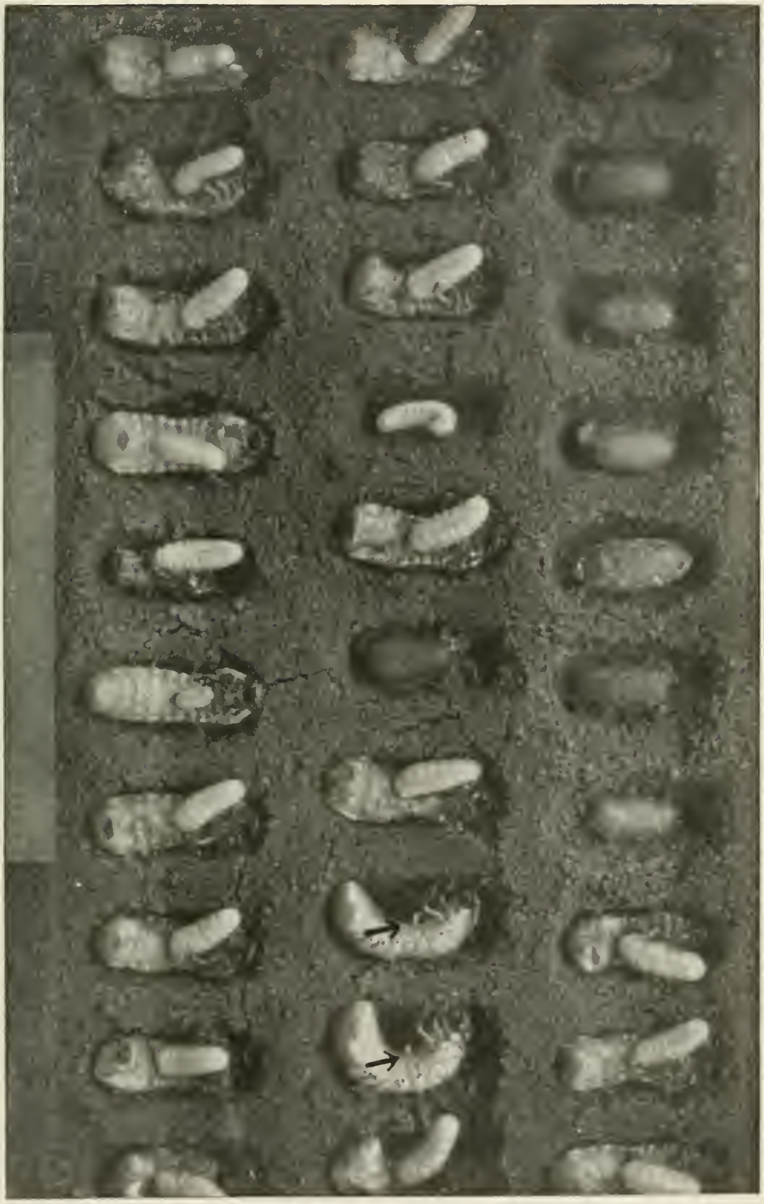
At first we only got an average of about one egg in two days from each wasp; but after observing the activities of a specimen which I had placed in a glass jar containing soil, I saw one of the difficulties. The wasp spent hours mining, round and round the jar, dragging the paralyzed grub after her, evidently in an endeavor to get it deep enough where the soil would remain moist, before forming a chamber and laying her egg. By supplying more moisture and examining the tins several times a day, I found that it was an easy matter to get a wasp to lay twice daily, and, in some cases as many as three eggs were produced in 24 hours.

It is interesting to note that when I put several grubs in the tin, the wasp straightway paralyzed them all, though she never laid on more than one. This led me to the conclusion that two eggs per day was perhaps her maximum average.

Mr. Jarvis experimented with various methods of caring for the grubs after they were parasitized, but none proved satisfactory for breeding on a large scale. They all required too much handling.

I, therefore, set to work to devise a plan, and began using boxes similar to the ordinary greenhouse "flat," a number of which I made up. These wooden trays are about 12 by 14 inches, inside measurement, and three inches deep. Soil two inches deep was firmly pressed into each of them and this was then indented with many oval cavities, just the shape of the bottom of the normal cell which the wasp makes in the soil, for the grub. I finally made a mold to form these depressions in the soil very rapidly; and I was able to get exactly 60 of them for each tray. See plate 19.

As fast as the grubs were parasitized, they were placed in these depressions on their backs and it was not necessary to handle them again. By this method they were as well separated as if in their original cells in the soil and they could not disturb one another; hence, the larvæ of the parasites developed very satisfactorily. However, when they finished feeding, and tried to spin up their cocoons, I found the same trouble that Mr. Jarvis had experienced when he kept the parasitized grubs in the bottom of small jars—the larval wasps were often unable to form the upper side of the cocoon, since the earthern cells had no roofs to act as points of attachment. In the case of the jars, I found that the cocoons were readily completed whenever I



Showing various stages in the development of wasps, as they appeared in the trays. Arrows indicate eggs in position. Cocoons of the wasps are to be seen in the cells on the right (Reduced, see scale).

dropped a bit of paper over them. I tried this in the trays when the larvæ were feeding, and found that it worked equally well.

The cocoons were then left in the cells to emerge; attention being given to keep the soil from drying out. There was not much difficulty experienced in this matter, since I kept the trays stacked, one upon another.

A small glass tube was inserted into the end of each tray, and this being the only entrance of light, the wasps naturally came into the tubes as fast as they emerged, and were easily removed.

It will be interesting to record here a further instance of parthenogenesis among parasitic hymenoptera. We found that wasps reared in the laboratory, with no opportunity for mating, began egg-laying at once when grubs were provided, and these eggs hatched producing larvæ of both sexes, though there was a preponderance of males, as one would naturally expect. However, these unmated females produced fewer eggs than normal, and the offspring emerged poorly.

THE SUGAR CANE BEETLE BORER PARASITE (CEROMASIA SPHENOPHORI) IN QUEENSLAND

By J. F. Illingworth, *Gordonvale, near Cairns, North Queensland*

This valuable Tachinid fly, introduced from New Guinea, in 1910, by Frederick Muir of the Hawaiian Planters' Association, has become thoroughly established in the Mossman district, and has done inestimable good.

It may be recalled that the beetle borer (*Rhabdocnemis obscura*) came into North Queensland, accidentally, about 1893, with importations of seedcane from New Guinea. This serious cane pest, which is second only in importance to the white grubs, has become well established in most of the northern districts, and already extends as far south as Mackay. Furthermore it is rapidly spreading to new territory through the indiscriminate exchange of seed between the different sugar centers.

The importance of this pest has long been recognized, especially by the Colonial Sugar Refining Company, who own a number of mills in the infested districts; and they made a serious, though unsuccessful attempt, in 1914, to introduce these Tachinid parasites from Fiji, where I had bred them and established colonies during 1913. They bred the flies in large field-cages at Goondi, on the Johnstone River; and though good-sized colonies were liberated, the parasites failed to become established. The season of 1914 was exceptionally wet; and as

that district normally has a heavy rainfall, it may have hindered the reproduction of the parasites, just at the time that they were getting started. This failure, however, led to the conclusion that, for some unaccountable reason, the Tachinids could not be established in North Queensland. Taking the above into consideration, I was particularly gratified to find that the flies had not only maintained their existence at Mossman, but had actually spread to even the most-distant portions of the district.

Previous to 1910 the beetle borer had become a serious pest at Mossman,—a fact which probably led Muir to select this locality as a station in his transfer of the parasites from New Guinea to Hawaii. In his bulletin[1] he states that before leaving Mossman it was found that a few of the escaped flies had established themselves in cane near the cages and were breeding quite freely. His work was carried on in the Mill Nursery; and fortunately for the parasites, this cane was not fired annually as is the custom with the ordinary field crops; hence there was an abundance of borer grubs, and the flies had every opportunity to multiply. Furthermore, seedcane was taken from this nursery to various parts of the district, and this undoubtedly was an important factor in the rapid distribution of the parasites. At any rate, in one case I found them fully 15 miles distant from this center, with long stretches of forest intervening.

The borer beetle is no longer a serious pest in the Mossman district —in fact it is thoroughly under control. In standing cane, it is now a difficult matter to locate a borer-grub that has escaped the vigilant search of these friendly insects. During the collection of the parasites for transfer to other infested districts, I estimated that fully 90 per cent of the grubs were destroyed by the flies. It was only where the stalks had fallen and were buried up by trash, that the grubs escaped.

The fact that these parasites have done so well at Mossman, is certainly very encouraging for their introduction into other nearby infested districts. This work I have undertaken as opportunity arose.

At first I tried transporting the parasitized grubs in the canes to the fields where I wished to establish the flies; but finding this a bulky procedure, I later collected only the grubs and puparia of the flies, which I carried in jars. By this method the grubs do not injure one another if a good quantity of frass is placed in the jars with them. I found it better, however, to separate the puparia into another jar, as fast as they emerged, to prevent the grubs destroying any that happened in their way.

By keeping the puparia covered with a plentiful supply of the frass

[1] H. S. P. A. Bul. 13, Ent. Ser.

it was easy to maintain correct moisture and air conditions, until the flies emerged, when they were placed directly in fields of borer-infested cane.

I have advised leaving the trash on the fields where I liberated the parasites, for at least one season, since the usual practice of burning when the crop is cut, though beneficial in destroying borers, is probably a rather serious set-back to the flies, until they are well established. Once they get a foothold, however, burning does not do them serious injury, and it is the best means we know of checking the borers. As a matter in point, all of the cane land in the Mossman district is burned over at the time that the crop is harvested, and still the flies maintain themselves well.

Natural Enemies of the Parasites

As I found in Fiji, the ants (*Pheidole megacephala*) are omnipresent in the cane fields of North Queensland. They often make their homes in the borer-runs, after clearing out the accumulated frass. Naturally predaceous, they are always ready for the flies as they emerge; and if they get them before their wings are expanded, the flies fall an easy prey. I have even observed the attack of the ants upon the mature insect, which is quickly overcome if they succeed in attaching themselves to the legs; the fly is then dismembered and carried away. It is only the perfectly healthy parasites that are able to escape, by eternal vigilance.

Fortunately, jumping spiders are not abundant in cane here, for they are a mortal enemy of the flies during the whole of their adult existence.

Swallows, and other insectivorous birds, are rather numerous in the fields, but I am not of the opinion that they act as a serious check upon parasites of this character, since the flies tend to spend their time down among the stalks of the cane plants, in their search for the borer grubs.

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A PRELIMINARY NOTE CONCERNING A SERIOUS NEMATODE DISEASE OF RED CLOVER IN THE NORTHWESTERN STATES

By Ralph H. Smith, *Associate Entomologist, University of Idaho, Moscow, Idaho*

Soon after taking up work in Idaho in May, 1918, the writer was asked to examine several fields of red clover in which the greater percentage of plants had either died or showed evidence of being badly diseased. The symptoms of the disease at this time were something like those of the stem rot of red clover that is caused by the fungus, *Sclerotinia trifoliorum* Erks. The widespread destructiveness of the malady during the autumn and early winter led to a careful investigation of the cause, with the result that the well known stem and bulb nematode of Europe, *Tylenchus dipsaci* Kühn, was found to be the primary pathogenic organism. No trace of any fungous parasite was found. Determination of the species was made by Dr. N. A. Cobb of the Bureau of Plant Industry.

Information that has been obtained from farmers indicates that this disease of red clover has been present in southern Idaho for several years and that it is rapidly increasing in its destructiveness. During the spring of 1919 several hundred acres of red clover had to be plowed up while a large percentage of the fields left were quite badly affected. The known distribution of the disease is limited chiefly to the irrigated sections of eastern Washington and Oregon, southern Idaho, and northern Utah.

The causal organism, *Tylenchus dipsaci* Kühn (syn. *devastatrix* Kühn) has been a well known destructive nematode of Europe since 1851 when, according to L. Reh,[1] it was described by Julius Kühn. It is remarkably polyphagous, having upwards of one hundred known species of host plants. In Europe it is a pest of clover, alfalfa, oats, rye, wheat, buckwheat, hops, beans, potatoes, onions, certain grasses, various ornamental plants, and numerous weeds. In England it is a leading cause of the malady long known as "clover sickness." During the past ten years it has become an important pest of different crops in New Zealand, Australia, and Cape Good Hope.

The occurrence of *T. dipsaci* in North America was first reported by Dr. E. A. Bessy who found it damaging a field of rye at Edgerton, Kansas, in the summer of 1907.[2] It was next discovered in the summer of 1913 at Bellingham, Washington, where it was the cause of a disease of hyacinths.[3] In 1915 Professor A. L. Lovett found it injuring red clover at Redmond, Oregon.[4] During the summer of 1916 Doctors N. A. Cobb and L. P. Byars of the Bureau of Plant Industry prepared

an article concerning the discovery of this pest in the Northwest and the article was distributed through the Office of Information of the United States Department of Agriculture. A reference to the disease of red clover was made in 1918 by Mr. A. C. Burrill who suggested that the trouble might be due to the attack of certain mites and the larvæ of the fungus gnat, *Sciara trifolii* Pett.[5]

Red clover seems to be the only plant that is seriously affected in the Northwest although occasional instances have been observed where alsike and white clovers were injured. This limited range of host plants may possibly be explained by the statement of certain European writers that there are different "biological strains" of *T. dipsaci*, each strain being specialized in its feeding habits to one host plant or to a few closely related host plants, so that it is unable to readily attack other species of the large number of plants that are listed as hosts of this nematode. It remains to be seen if the *T. dipsaci* that is causing such severe damage to clover in the Northwest will eventually become a pest of the numerous crops which the species is said to attack in Europe and other foreign countries.

The nematodes appear to enter the clover plants at the surface of the ground, first working into the stipules of the leaves which surround the developing stems and later entering the stems. The infested parts near the ground become enlarged, spongy, and finally turn brown and rot off. The worms also occur higher up in the stems, and in the leaves and branches where they cause distortions and enlargements. The malforming of plants is most pronounced in autumn and early winter. During the summer the foliage of affected plants usually has an unhealthy, striped-yellow appearance and the plants as a whole are more or less stunted.

The death of diseased plants is hastened in the greater number of cases by the work of secondary agents, the most important of which seem to be the root mite, *Rhizoglyphus rhizophagus* Banks, the larvæ of the mycetophilid, *Sciara trifolii* Pett., and the larvæ of *Sitones hispidulus* Germ., a snout beetle that is common in clover fields in the Northwest. The greater injury results to clover fields the second year or longer after seeding when both the nematodes and the insects are found to be more abundant. Several fields have been observed, however, which had to be plowed up the first year after seeding.

Considerable work on the control of this nematode has been carried on in Europe and such measures as trap plants, rotations with immune crops, deep plowing, fallowing, application of various chemicals to the soil, and intensified cultivation have been recommended. It has been found that the larvæ of the worms can remain dried up for a period of two and one-half years without loosing their viability. This, along

with the possibility that the worms may come to thrive on many of the common weeds and field crops of the arid sections of the northwestern states, as it does in Europe, presents a more serious problem of control than has been dealt with by European investigators. The writer has made studies which show that the nematodes may be spread through the hay, straw, and, to some extent at least, through the seed from infested clover fields. They are also doubtless carried on the feet of animals, the wheels and other parts of farming implements, and to some extent in the water of irrigation ditches. It is probable that irrigation water plays an important part in spreading the worms from infested plants to other plants in the same field.

It is anticipated that the futher investigation of the problem will be conducted as a coöperative project between the Idaho Experiment Station and the Bureau of Plant Industry.

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A MIGRATING ARMY OF MILLEPEDS

By Fred E. Brooks, *Bureau of Entomology, Entomologist, Deciduous Fruit Insect Investigations*

During the past fifteen years the writer has on several occasions observed in the central part of West Virginia armies of millepeds, *Fontaria brunnea*, migrating over the ground in woods and fields. These armies have moved either in scattered or densely formed companies, sometimes only two or three to the square foot and at other times averaging a hundred or more to the square foot. In one or more instances the millepeds have been known to invade strawberry plantations at the time the fruit was ripening where they would coil about and feed upon the over-ripe fruit and so cover the ground about the plants that picking of the fruit had to be abandoned. One man informed the writer that while gathering wild blackberries he chanced to look down and saw his shoes and all the ground about them covered with a mass of crawling thousand-legged worms, whereupon he beat a hasty retreat. Such armies have been seen by the writer at Hampton and near Buckhannon, in Upshur County; near Weston, in Lewis County; and, more recently, near Littleton, in Wetzel County.

Early in July, 1918, the local newspapers published accounts of "a great army of worms" which was causing much discomfort and excitement in the vicinity of the village of Littleton, which is situated on the Grafton-Wheeling division of the Baltimore & Ohio Railroad. The writer, being in the locality, took the trouble to investigate, and, on July 13, found a remarkable occurrence of millepeds, specimens of which have been determined by Popenoe as *Fontaria virginiensis* Drury. The army had first been observed about four weeks previously moving in a southerly direction over the farm of two brothers, L. L. and James Fox, about one mile from Littleton. At least seventy-five acres of field and woodland had been covered with the millepeds, which, in the opinion of the Fox brothers, came from a tract of woodland nearby, known as the Welsh Woods. Both the brothers stated that a small barn on the farm was at one time covered with a solid mass of the creatures from the ground to the tip of the roof and that they formed in heaps about every decaying stump and piece of mouldering wood. The spring from which the families obtained water was filled to a depth of six or eight inches with drowned millepeds and water for all uses had to be carried from without the infested area. Cattle refused to graze on pastures invaded by the army, and, in cultivating corn, the workmen declared they were nauseated and made dizzy by the constant odor arising from the millepeds crushed by the hoes. This odor, they describe as being like that of cherry bark, but much more offensive. It was stated that during the warmer part of clear days masses half as large as a barrel would collect in damp and shady places, but that in cloudy weather and at night the army was moving constantly.

At the time the writer visited the Fox farm the army had passed on and only a few living millepeds could be found. Old stumps, posts, rails and decaying boards, however, bore evidence of the invasion for they were in many places gnawed white and were covered with small dots of earth-like excrement. From information given by the Fox brothers and many other persons, together with what the writer himself saw of the army, it was estimated that the army was composed of not fewer than 65,340,000 millepeds.

When seen by the writer the army had migrated about a mile from the Fox farm and the main part of it was centered about the home of M. G. McDougle, which is at the foot of a high cliff of rocks beside the railroad track. In its movement the army had come to the top of the cliff and the millepeds had descended by crawling or rolling to the bottom. Mr. McDougle stated that on the morning following the coming of the army to his home he opened a screen door between his kitchen and back porch and that the door in swinging back swept

up a heap of the millepeds a foot in height. He immediately got a shovel and cleaned up two washtubsful from the porch and from a small ditch that extended along the side. Every morning thereafter for two weeks he collected a half-bushel or more about his house and carried them away. The barnlot where the family cow grazed was so covered with the millepeds that Mrs. McDougle left her cow unmilked for three consecutive milking times and the small stone cellar in which the milk was kept was so overrun that it had to be abandoned. G. W. Mackey, a Baltimore & Ohio section foreman, said that he saw a pile of the millepeds at the foot of the cliff two feet in height which he estimated to contain five bushels.

At the time of the writer's visit there were thousands of the millepeds crawling over the face of the rocks and on the ground above and below and showers of them were dropping at intervals over the declivity. They had been present about the McDougle home for more than two weeks and all observers agreed that the number was now greatly reduced. The hot sunshine on the bare cliff, and on the railroad ballast at the bottom, was killing them rapidly, as was indicated by the number of dead. In many places at the foot of the cliff the ground was completely hidden by the dead bodies and the stench was offensive. The McDougles had poured lime and concentrated lye on the ground, forming a heavy line around the yard to keep the millepeds from crossing, but with little avail. They stated that neither chickens nor anything else was observed to feed on them. The good woman of the house was almost in despair, for, in her own words, "she had fit those worms with consecrated lye and every thing else she could think of and hadn't been able to do a lick at anything else for nearly three weeks."

Neither mating nor oviposition were observed, although looked for rather carefully. Mrs. McDougle had noticed that some of the millepeds were full of eggs and the writer dissected one rather small female which contained 690 eggs. All the abdominal cavity except the space occupied by the slender alimentary canal was packed full of eggs. Most of the millepeds seemed to be full grown although some were noticed whose immaturity was indicated by the smaller size and paler color.

Reports were current of similar armies at Woodruff, Garrison and Sand Hill Church, all near Littleton, but the writer did not investigate these reports. It is interesting to note that small companies of the millepeds are said to have been seen in woods near Littleton in 1916 and 1917. These may have been the progenitors of the great army that appeared during the present year.

Scientific Notes

Occurrence of the Argentine Ant at Raleigh, North Carolina. On September 20 the writer, much to his surprise, found a heavy infestation of this troublesome ant in a floral establishment here. The florist, Mr. O'Quinn, stated that this ant has given him much trouble for about fifteen years, especially in the winter when the workers flock to the green houses for warmth and occur over everything. Mr. O'Quinn also stated that they cause considerable damage to his carnations by cutting off the petals at their bases.

The ants also occur on several blocks adjacent to the florist's establishment, where they are giving the people much trouble by infesting houses.

The only other locality in this state, in which the Argentine ant is known to occur, is Wilmington, where it was found several years ago by Mr. E. R. Barber, of the Bureau of Entomology.

M. R. Smith,
Extension Entomologist, North Carolina State Department of Agriculture

The Cocoanut Butterfly, Brassolis isthmia, on Banana. My attention was first called to the occurrence of larvæ of *Brassolis isthmia* Bates on banana by Mr. Ignacio Molino of the Bureau of Entomology, U. S. D. A., Temporary Field Station at Ancon, C. Z. He found them on banana trees in his gardens in Panama city. An inspection made September 5 revealed four palms completely stripped, two palms partly stripped, one banana tree with one leaf completely chewed off excepting the stout mid rib, and two banana trees with large holes eaten through several leaves. Larvæ of *Brassolis* were congregated in bunches both on the palms and banana plants. To make sure that the injury noted was done by the cocoanut butterfly, an inspection was made at night the same day. When about ten feet away from the banana trees a very characteristic noise was heard,—that of the mandibles of dozens of large larvæ making rapid progress through the thick, fibrous tissues of the banana leaves. It was a loud noise, not easily forgotten. This inspection confirmed the identification of the species.

The following day, 6th, one entire leaf, measuring $4\frac{1}{2}$ feet by $1\frac{1}{2}$ feet was found to be completely stripped to the mid rib; a few more leaves had large holes eaten through them. The larvæ feed from the dorsal surface, and start from the edge of the midrib, working outward. Observations made on subsequent days showed that a large leaf was stripped daily. The inhabitants of the house told me that at first the noise produced by these larvæ was so unique and loud that it interfered with sleep; these people live only about fifteen feet from the trees.

B. isthmia is a very serious pest of palms, principally of our cocoanut palms (see H. F. Shultz, '08, Proc. Ent. Soc. Wash., and L. H. Dunn, '17, Journ. Econ. Ent.). This is the first record of its occurrence on banana, and while it may never become a serious pest of bananas, the fact that it takes readily to banana leaves and eats them with vigor, is enough to emphasize the need of control work. The method that has been recommended is the cutting out and burning of the nests in the palms, however, this method is not thorough enough; it is believed spraying with an arsenical will prove more effective. Attention is called to the fact that in banana plantations there are innumerable cut stalks and other forms of débris scattered about, and that these afford admirable shelter for the mature larvæ when ready to pupate. It would appear, therefore, that if once established on banana, it will become a serious pest. This species should be included in Doctor Pierce's "A Manual of Dangerous Insects Likely to be Introduced in the United States Through Importations."

James Zetek, *Ancon, Canal Zone*

Stable Flies and Chiggers. While making studies on the chigger mites during the past summer in the vicinity of Washington, D. C., large numbers of stable flies (*Stomoxys calcitrans*) were found to be parasitized by a small red chigger. A determination of the species concerned shows it to be *Trombidium striaticeps* Oudemans, the striated chigger of Europe, which is said to be one of the three species concerned in the attacks on man and domesticated animals in that continent. In view of the fact that the specific identity for all species attacking man and domesticated animals in this country is in doubt, it is believed that the record of the occurrence of this European species in our country is of much significance. That it should be found so abundantly on stable flies in Washington is surprising, yet Dr. L. O. Howard informs me that in the past he has observed stable flies in the vicinity of Washington with chiggers attached.

H. E. Ewing

On the Bite of Arilus cristatus. On September 22, 1919, the writer was collecting along the banks of the Potomac River at Williamsport, Md. Adults of *Arilus cristatus*, the wheel bug, were very numerous, engaged in feeding on a large variety of insects and in mating.

A considerable number of these adults were picked up for life-history studies, a male of which sunk its proboscis into the forefinger of the writer's right hand. The wound was at once very painful and remained so for ten days, at first appearing red, and the portion adjoining the wound more nearly, becoming hardened and quite white. On the 26th it was necessary to lance the wound to let out considerable bad blood and puss, and the finger was not normal until about the third of October.

George W. Barber,
Scientific Assistant, Bureau of Entomology, U. S. Department of Agriculture

A Note on Migration of Larvæ of the House Fly. Along a stretch of some 150 feet of road in Wellington, Kans., there is found a strip of grass about two feet wide along one side of which a cement sidewalk runs and along the other a cement curb raised perhaps eight inches above the macadamized road with which it is connected. The whole is gently sloping to the West.

About the 15th of May, 1917, this grass area, as well as a plot of some two acres adjoining the sidewalk, was covered with a thick layer of barnyard manure which had probably been stacked for some time.

A few days later, about six o'clock in the morning, in passing by this stretch of road, large numbers of the larvæ of the house-fly, *Musca domestica*, were observed on the sidewalk and in the gutter adjoining the manured strip. They were only fairly numerous on the sidewalk, but in the gutter they lay in a white band extending the whole length of the manured space, perhaps eight inches wide and towards the curb several larvæ deep.

This whole seething mass was working down the street towards the West and were found to be entering a sewage manhole which adjoined the West end of the manured area.

By noon, this date, practically all the larvæ had disappeared.

Considering that the majority of the larvæ had entered the manhole, they had migrated from one to one hundred and fifty feet depending on which end of the manured area they left the manure. And they had preferred migrating this distance in search of soil in which to pupate rather than enter the soil beneath the manure.

George W. Barber,
Scientific Assistant, Bureau of Entomology, U. S. Department of Agriculture

Brood X of the Periodical Cicada in Missouri. In Missouri Agricultural Experiment Station Bulletin No. 137, "The Periodical Cicada in Missouri," the writer published the records of distribution of Brood X Septendecim collected by Professor Stedman in the summer of 1902. At the time of preparing the data for publication the writer carefully went over the original records and included only those which seemed without doubt to be accurate.

This brood appeared again this year and a new set of records have been collected and tabulated. The records for 1902 showed the pest to be quite generally distributed over much of the eastern half of the state and in some localities in considerable abundance. It will be of interest to know that if the records for 1902 were correct this brood of the Cicada is rapidly disappearing in Missouri. The 1902 records showed it to be present in thirty-two counties while in 1919 records received just after the time of disappearance showed that Cicadas appeared in only four counties. Cape Girardeau, Hickory, Perry, Puloski and possibly Carter. The localities are widely separated and in no case were the Cicadas abundant. Since early arrivals are known to appear one year in advance of regular broods, it is quite possible that some of the Cicadas observed this year may have been early arrivals of Brood XIX of the thirteen-year form, which appears over most of Missouri next year. Be this as it may it is clearly evident that Brood X is of little consequence in Missouri.

L. Haseman.

Swarms of Cotton Worm Moths visit Missouri. Since 1911 the fall migration of the cotton worm moth (*Alabama argillacea* Hbn.) has not attracted any special attention in Missouri, but during the last of September and the first two weeks of October the moths appeared in great numbers in the state, doing some damage to ripe fruit. During this visitation the moths were not nearly so abundant as in 1911 but around piles of decaying fruit, tomatoes, persimmons and other attractive bait they have been observed to collect in swarms. In a moth trap set at Columbia on the night of October 14, facing an orchard and vegetable plats, and at a distance of one hundred yards from them only a few moths were caught. Careful examination on the following day showed that but few moths remained.

It will be of interest to learn if this is another year of extensive northward migration of this queer moth, similar to the fall of 1911.

L. Haseman.

// JOURNAL OF ECONOMIC ENTOMOLOGY
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DECEMBER, 1919

The editors will thankfully receive news items and other matter likely to be of interest to subscribers. Papers will be published, so far as possible, in the order of reception. All extended contributions, at least, should be in the hands of the editor the first of the month preceding publication. Contributors are requested to supply electrotypes for the larger illustrations so far as possible. Photo-engravings may be obtained by authors at cost. The receipt of all papers will be acknowledged —Eds.

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Judging from the trend of affairs, it may be necessary to limit more closely than heretofore the acceptance of matter for the Journal. The Proceedings of the Annual Meeting and those of Branch Meetings have by common consent been given precedence in the past. It is presumable that this policy meets with general approval and will be continued. The editor has in the past suggested some condensation or even the withdrawal of papers read at the meeting, this action being based on various considerations. It is not quite fair to submit a forty-minute manuscript for a fifteen-minute paper, though circumstances may very occasionally justify it. The limited resources available make it impossible for the Journal to publish many twenty-page contributions and afford a fair opportunity to the many lines of activity seeking an outlet through its pages. In the same way, the relatively costly tabular matter and illustrations, both desirable in themselves, are self-limiting with our restricted resources. It has been the editor's aim to give preference to new matter, preferably concisely stated, because it is only by observing some such rule that the Journal can under present conditions fill the place it should occupy in economic entomology. There is so much new matter available, that summaries or digests of previously known facts, published illustrations, exhaustive tabulations and detailed accounts of investigations all come in a class which conditions make it difficult to publish unless justified by special considerations.

CURRENT NOTES.

The fall field meeting of the New Jersey Beekeepers Association was held at New Lisbon, September 10.

The fifty-sixth annual meeting of the Ontario Entomological Society was held at Ottawa, November 6 and 7.

The fall convention of the Connecticut Beekeepers Association was held at the state capitol, Hartford, October 11.

Dr. J. H. Merrill, assistant entomologist of the Kansas Agricultural Experiment Station, is now state apiarist of Kansas.

Dr. L. O. Howard attended the meetings of the National Academy of Sciences at New Haven, Conn., November 11 and 12, 1919.

According to *Science*, Major General W. C. Gorgas has been elected an honorary member of the National Academy of Medicine of Peru.

Prof. H. A. Gossard of the Ohio Station visited the Gulf states early in September and visited the State Entomologist of Georgia, on his way home.

Mr. Rossiter D. Olmstead has recently been appointed assistant in entomology at the New York Agricultural Experiment Station at Geneva, N. Y.

The New Hampshire Beekeepers Association was formed at Durham, N. H., on August 19, about seventy-five being present at the meeting at the college.

According to the Ohio Experiment Station News, grasshoppers have been more abundant and have caused more damage this year in Ohio than for twenty years.

Additional resignations, Bureau of Entomology: F. L. McDonough, Tobacco insect investigations; H. F. Dietz, tropical and subtropical fruit insect investigations.

Mr. H. E. Ewing, formerly of the Iowa Agricultural College, is now connected with the Bureau of Entomology at Washington, and will give especial attention to a study of mites.

Dr. W. D. Pierce, a former member of the Bureau of Entomology, announces the incorporation of the Gage-Pierce Research Laboratories with headquarters at Denver, Colorado.

Mr. A. J. Flebut has returned from military service and has been reinstated in the Bureau of Entomology, and will have charge of the laboratory at Fresno, Cal., investigating grape insects.

Mr. C. F. Stahl, Bureau of Entomology, engaged in sugar beet insect investigations in California, reports almost complete injury of sugar beets by the curly-top leafhopper in Riverside County.

Dr. E. P. Felt read a paper before the National Association of Commissioners of Agriculture at Chicago, November 10, outlining a comprehensive program for dealing with the European corn borer.

Mr. J. C. Evenden, Bureau of Entomology, formerly entomological ranger and during the war captain in Company G, 363 Infantry, with the American Expeditionary Forces, in France, has returned to the Branch of Forest Entomology as scientific assistant and is stationed at Coeur d'Alene, Idaho, under general direction of F. G. Miller.

Mr. D. L. Van Dine, of the Bureau of Entomology, having received his discharge from the Army, was reinstated in the bureau on August 4. He returns to the malaria mosquito work at Mound, La.

Mr. C. A. Weigel, Bureau of Entomology, is in Florida making a preliminary investigation of the camphor thrips situation. A permanent assistant is to be assigned to this project in the near future.

Mr. H. F. Dietz, Bureau of Entomology, has returned from the Canal Zone where he has been conducting research and experimental work for the past year, and is now engaged in preparing a report in this country.

Mr. E. R. Barber, Bureau of Entomology, has returned to his station in New Orleans after spending several months in Cuba collecting parasites of the sugar cane moth borer for shipment to the United States.

The Northern Idaho Beekeepers Association was organized at Sandpoint June 26, 1919. Arthur Sires of Sandpoint was elected president, E. A. Anthony of Rathdrum, vice president, and E. L. Ludwick, secretary and treasurer.

A conference of entomologists was held in Columbus, Ohio, August 11, to consider the European corn borer. The conference was called by N. E. Shaw, secretary of the State Board of Agriculture, and Professor H. A. Gossard was present.

Messrs. C. A. Weigel and E. L. Chambers, Bureau of Entomology, have just completed some successful experiments in controlling the adult of the grape rootworm which appeared in great numbers in a local greenhouse damaging roses.

Mr. M. M. High, Bureau of Entomology, in charge of sweet-potato weevil investigations in Texas, will visit points in the interior of Mexico for the purpose of securing parasites of the sweet-potato weevil for introduction into the United States.

Mr. F. H. Wolley Dod of Midnapore, Alberta, B. C., died July 24, 1919. Mr. Dod was a pioneer collector and student of the lepidoptera of Alberta, especially Noctuidae, and he has published many articles in *Canadian Entomologist* during the past twenty years.

Prof. Vernon L. Kellogg has been elected executive secretary of the National Research Council. Professor Kellogg is also chairman of the Councils division of educational relations, and a director of the American Relief Administration European Children's Fund.

Dr. M. C. Tanquay, associate professor of entomology, Kansas State Agricultural College, has resigned to accept the position of state entomologist of Texas, and chief of the division of entomology of the Texas Agricultural College. His resignation takes effect February 1, 1920.

Mr. W. R. Walton of the Bureau of Entomology in charge of cereal and forage crop investigations has recently made a tour of the Middle West, Pacific Northwest, and Southwest, visiting the laboratories under his direction, and called upon Director Hecke of Sacramento, California, August 8.

Mr. F. C. Bishopp of the Bureau of Entomology spent a large part of the month of August traveling in Arizona with the Arizona "Live Stock Squad." Public meetings and demonstrations were held in various parts of the state in the interest of the live stock industry. He reports a very successful trip.

Additional transfers, Bureau of Entomology: R. H. Van Zwaluwenberg, recently on European corn borer work, to Hagerstown, Md.; C. A. Bennett, Federal Horti-

cultural Board, to camphor thrips investigations, Florida; C. A. Weigel, camphor thrips investigations, Florida, to Washington, D. C.

Dr. Burton N. Gates, formerly in charge of bee culture at the Massachusetts Agricultural College, Amherst, Mass., who resigned to accept a similar position at the Ontario Agricultural College, Guelph, Ontario, Canada, has given up this position and returned to Worcester, Mass., to take up another line of work.

Mr. R. L. Webster, Department of Entomology, Cornell University, spent the month of August in southern California, studying the fumigation of citrus trees. The state insectary at Sacramento, the government entomological laboratories at Alhambra and the entomological laboratory at Riverside were visited.

Entomologists will be pleased to learn that according to the press of October 20, the Grand Duke Nicholas Micholaivitch, who was several times reported dead, is alive and for several months has been living on Prinkipo Island in the sea of Marmora. He is a well known entomologist and has published several volumes, mostly on the Lepidoptera.

Mr. George N. Wolcott, a former employee of the Bureau of Entomology, has been reëngaged to take charge of a coöperative project between the Bureau and the Bureau of Plant Industry. The project in question is an investigation of possible insect transmitters of the sugar-cane mosaic disease. Mr. Wolcott's field of operations will be Porto Rico.

The Bureau of Entomology in coöperation with the Extension Division and Department of Entomology of the University of Wisconsin, gave an extension short course for commercial beekeepers at Madison during the week of August 18. The meetings were in the nature of a Chautauqua. The total attendance was 160, the largest at any such school to date.

Additional appointments, Bureau of Entomology: Samuel Blum, Cornell University scientific assistant, Southern corn root-worm investigations, Columbia, S. C.; Joseph Edwin Fouser, Ohio State University, scientific assistant in testing proprietary insecticides; M. D. Leonard, Cornell University, and H. W. Allen to European corn borer investigations, Arlington, Mass.

According to *Canadian Entomologist*, Mr. W. Downes, temporary assistant at the Dominion Entomological Laboratory at Victoria, B. C., has been appointed a junior entomologist and will assist Mr. R. C. Treherne, entomologist in charge for British Columbia, in the investigations on small fruit insects that are being conducted on Vancouver Island and the Lower Fraser Valley.

Arrangements have been made by the Bureau of Entomology in coöperation with the extension services of the several states to conduct short courses for commercial beekeepers this fall as follows: North Yakima, Wash., Nov. 10–15; Davis, Cal., Nov. 17–22, Fresno, Cal., Nov. 24–29; Riverside, Cal., Dec. 1–6; San Diego, Cal., Dec. 8–13; San Antonio, Tex., Dec. 15–20; Manhattan, Kans., week of February 8; Ithaca, N. Y., week of February 23, 1920.

Observations in Virginia, Maryland, and New Jersey on the Colorado potato beetle indicate that extensive parasitism explains the material decrease in numbers during the present season. In the individuals of the first generation more than 25 per cent appear to have been parasitized, while parasitism in the second generation is almost complete. Workers in a position to observe and transmit to the Bureau of Entomology parasitized individuals of the Colorado potato beetle will confer a favor by so doing.

Mr. Ernest Hargreaves, who visited the United States in 1915, entered the British military service soon afterward, and was engaged during the remainder of the war, spending most of the time in Italy on anti-malaria work, which was very successful, has been discharged from military service and is now demonstrator in entomology at the Imperial College of Science and Technology, South Kensington, London.

Recent appointments to the Bureau of Entomology are as follows: Prof. S. T. Howard, Clemson College, S. C., as mechanical engineer, boll weevil force, Tallulah, La.; G. D. Dorrah, J. H. Huff, C. P. Smith, M. C. Rogers, C. H. Williams, (temporarily) boll weevil force; L. B. Sanderson, W. G. Bemis, F. W. Grigg, E. M. Searls, H. R. Carpenter, H. L. Parker, B. E. Hodgson, H. J. Cronin, C. S. Anderson, H. J. Authier, F. L. O'Rourke, J. H. Kelley, C. W. Knapp, corn borer laboratory, Arlington, Mass.

A hearing was held in Washington, D. C., October 8 regarding an appropriation to check the spread of the European corn borer, before a subcommittee of the United States Senate. There were present commissioners of agriculture from Massachusetts, New York, Delaware and Virginia and the following entomologists: E. P. Felt, P. J. Parrott, C. R. Crosby, New York; W. E. Britton, Connecticut; J. G. Sanders, Pennsylvania; E. N. Cory, T. B. Symons, Maryland; W. P. Flint, Illinois; E. D. Ball, Iowa.

Recent transfers in the Bureau of Entomology have been announced as follows: William O. Ellis, Japanese beetle investigations, Riverton, N. J. to European Corn Borer work; F. L. Simanton, Benton Harbor, Mich., and Monticello, Fla., to Hessian fly work at Centralia, Ill.; C. F. Turner, West Lafayette, Ind., to take charge of the European Corn Borer work at Schenectady, N. Y.; George B. Fisher, corn borer work, Arlington, Mass., to Hessian fly work, Wichita, Kans.; R. J. Fiske, Columbia, S. C., to West Lafayette, Ind.

T. E. Holloway, of the Bureau of Entomology, reports that the Cuban parasites of the sugar-cane moth borer, which were imported during the past summer, were allowed to emerge in cages at his laboratory in Audubon Park, New Orleans, and were then released on three plantations in different parts of southern Louisiana. He has just found that they are breeding at all three plantations, having passed through probably three generations in Louisiana. The prospect for establishing them, if they can live through the winter, is very good.

Annual meetings of various beekeepers associations were arranged to be held as follows: Eastern New York Beekeepers Association, County Court House, Albany, Nov. 20; Western New York Honey Producer's Association, Genesee Hotel, Buffalo, Nov. 14 and 15; Michigan Beekeepers Association, Lansing, Dec. 9 and 10; Ontario Beekeepers Association, Carls Rite Hotel, Toronto, Dec. 11, 12 and 13; Illinois State Beekeepers Association, Springfield, Dec. 9 and 10; Kansas Beekeepers Association, Topeka, Dec. 18 and 19; Northern Illinois and Southern Wisconsin Beekeepers Association, Rockford, Ill., October 21.

In a recent communication from Dr. O. F. E. Winberg of the Bureau of Entomology, who has been acting in charge of the work against the sweet-potato weevil in the state of Alabama, it is stated that the most thorough investigations and inspections so far during the present harvest season have failed to show the presence of the weevil in the Grand Bay district, in which a small number of farms showed infestation two years ago. The measures adopted have been the destruction of all infested sweet potatoes, through clean culture, hogging down the infested patches, and careful inspection of new plants known to be weevil free or to have been brought from weevil-free districts.

The outlook accordingly is very encouraging, and it is hoped that additional efforts in the adjoining portions of Mississippi may accomplish the same benefits and that work for another season or two in Baker County, Fla., may be equally productive.

The use of the aeroplane for scouting for the pink bollworm has been reported in previous issues of the Monthly Bulletin (California) of the old Horticultural Commission. This work recently has received a serious setback as the result of a fatal accident which happened on August 7, in which both Lieutenant Tillisch, pilot, and E. L. Diven, the technical observer of the board, lost their lives. Lieutenant Harold Compero, of the office of pest control of this department, was the original pilot and when mustered out was relieved by Lieutenant Tillisch. The flights had been conducted for a considerable period without serious accident. The danger of this service was fully recognized, but it was hoped the board's record would be a clean one, except as to accidents of a minor character. Both Lieutenant Tillisch and Mr. Diven were men of high character and undertook the work with a full realization of the personal risk.

Director Hecke of California has received advices from E. W. Rust, parasite collector attached to the office of pest control of the new Department of Agriculture, that he safely arrived at Cape Town, August 13 last. Mr. Rust will be engaged for some time in locating, rearing and packing beneficial insects for transportation to California, where they will be propagated for use in black scale and mealybug infested localities. Mr. Mally, the entomologist at Cape Town, has furnished Mr. Rust with all the facilities at his command, including a well-equipped laboratory. From Cape Town Mr. Rust will proceed to Pretoria, where he will confer with C. P. Lounsbury, entomologist for the S. A. Department of Agriculture, the governor-general and the minister of agriculture. On the voyage to Cape Town Mr. Rust was in company with the African Expedition of the Smithsonian Institute at Washington, D. C. In the expedition were Edmund Heller, biologist, late of the Roosevelt Expedition, in charge of the party, Dr. Shantz, botanist, Dr. Raven, zoölogist, and six other members, representing the moving pictures and newspapers.

Resignations from the Bureau of Entomology have been announced as follows: M. R. Smith, South Carolina; J. D. Smith, Charksville, Tenn.; R. L. Nougaret, Fresno, Cal., to become head viticulturist of the California State Horticultural Commission; Lester E. Palmer, Federal Horticultural Board; A. E. Mallory, Greeley, Colo., to enter educational work; H. K. Laramore, Plymouth, Ind., to enter commercial work; F. M. Wadley, Muscatine, Iowa, to complete his studies for an advanced degree at the Kansas Agricultural College; Neil F. Howard to accept a position with the Goodyear Rubber Co., at Akron, Ohio; F. R. Cole, Forest Grove, Ore., to resume his studies at Stanford University; C. W. Curtin, D. P. Perry, A. F. Leamy, T. F. Murphy, H. E. Partridge, E. D. Lothrop, all of the corn borer laboratory, Arlington, Mass.; W. H. Dumont, to enter college; temporary employees, L. R. Wilbanks, C. P. Smith, G. W. Alexander, J. B. Pope, H. C. Young, A. L. Williamson, O. A. Hammett, C. H. Brannon, L. W. Brannon, J. P. H. Clayton, B. M. Deavenport, G. D. Dorrah, W. W. Alexander, J. T. Lewis, P. J. Wyatt, L. N. Judah, J. W. Hill, Scott C. Lyon, S. F. Gribbs, M. L. MacQueen, W. N. Haley, L. R. T. Cowen, G. L. Lott.

There has been considerable reorganization of the Federal Horticultural Board made necessary by the enlargement of its work as a result of the nursery stock, plant, and seed quarantine No. 37, and the taking over of the direction of the fumigation of railway cars, freight, etc., on the Mexican border. R. Kent Beattie has been placed in administrative charge of the enforcement of all the quarantines and orders

restricting the entry of foreign plants and plant products. This includes nursery stock and plant and seed importations, cotton importations, and importations of fruits, grains and other plants and plant products brought under restriction. E. R. Sasscer has been placed in charge of all port inspection work necessitated by the various foreign plant quarantines administered by the Department. This assignment covers the Mexican border inspection and quarantine service and the inspection offices now maintained by the Board at the principal ports of entry in the United States, namely, New York, Boston, New Orleans, San Francisco, and Seattle. The Texas border service has been enlarged by the establishment of an inspection office at Nogales with H. M. Cely, formerly connected with the Texas pink boll-worm work, in charge. The port inspection service has been further strengthened by the addition of the following new inspectors: Emile Kostal, graduate of Cornell, assigned to New Orleans; George F. Arnold, graduate of the Mississippi A. and M. College, assigned to Eagle Pass; J. B. R. Leary, graduate of the Texas A. and M. College, transferred from Dr. W. D. Hunter's roll to the port of Laredo; Macco M. Richardson, fumigation mechanic, assigned to Brownsville; and L. L. Spessard, graduate of the University of Washington, assigned to Washington, D. C.

At the last session of the California State Legislature all agricultural work was consolidated into one Department known as the State Department of Agriculture. All pest control work is consolidated into the Office of Pest Control, of which the following is the staff:

Office of Pest Control

Harry S. Smith, Entomologist in Charge

W. C. Jacobsen	*Superintendent, Rodent Control*
D. B. Mackie	*Field Entomologist*
H. M. Armitage	*Assistant Entomologist*
E. W. Rust	*Parasite Collector*
E. J. Branigan	*Field Assistant*
A. E. Gray	*Field Assistant*
Harold Compere	*Laboratory Assistant*
Paul Howard	*Laboratory Assistant*
Marshall Monroe	*Laboratory Assistant*
W. M. Phillipson	*Inspector*
Harry Stiner	*Inspector*
A. A. Brock, Santa Paula	*Collaborator*
Dr. Joseph Grinnell (Berkeley, Cal.)	*Consulting Zoölogist*
Joseph Dixon (Berkeley, California)	*Special Investigator*

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